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Coming out of COVID-19 lockdown

The next steps for Australian
health care

Stephen Duckett



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Overview

The SARS-CoV-2 virus (coronavirus) galvanised a public health response not seen in Australia for more than a century. To prevent its spread, and the disease it causes, COVID-19, social and economic activity was shut down. Australia emerged with low numbers of deaths, and a health system which coped with the outbreak.

Australia's response passed through four phases – containment, reassurance amid uncertainty, cautious incrementalism, and then escalated national action – as the gathering storm of the pandemic became more apparent. Now we are in the fifth phase – transition to a new normal.

There were four key successes in the response: cooperative governance informed by experts (most notably seen in the establishment of the National Cabinet), closure of international borders and mandatory quarantine, rapid adoption and acceptance of social distancing measures, and expansion of telehealth.

The health system mostly adapted well to the pandemic challenge. Governments rapidly prepared to expand intensive care unit capacity, and redeploy staff and equipment to this new higher priority. Doctors and clinics pivoted quickly to telehealth.

But unfortunately there were also four key failures: the mishandling of the Ruby Princess cruise ship had fatal results, borders weren't closed quickly enough, some aspects of the health system response were too slow, and there were mixed messages about what was expected of the population.

Australia is now in the fifth phase, a transition to 'a new normal'. Unless or until there is a vaccine, this stage has no endpoint. We all will live with the risk of more outbreaks and shutdowns, and the need for vigilance and swift responses to outbreaks.

Choices are being made about how and when the lockdown will be eased, with each state and territory taking a different path. While the virus continues to circulate, there will be a risk of a second wave.

In this report we describe a model developed at Grattan Institute which simulates the risks of different relaxation strategies, and we draw some lessons for the health system. We show that some strategies, such as reopening schools, involve some risk of outbreaks, but these outbreaks most likely can be controlled. We highlight those strategies which are riskier, particularly reopening large workplaces. As those workplaces reopen, employers should be required to implement protocols to minimise transmission of the virus. This may require fewer people being at work at any one time, with staggered start and finish times and even staggered working days.

Seven lessons from the health system response should be incorporated into a new normal: expand telehealth; expand hospital-in-the home; encourage outreach and telehealth with new primary care funding models; restart public elective surgery differently, including using private hospitals; improve health system readiness by better planning and coordination; strengthen supply chains to ensure supplies of personal protective equipment and ventilators in the event of a second wave or new pandemic; and build better on-the-ground coordination.

Planning for this transition is as important as the planning of the response during the initial wave of the pandemic. Without good planning for the transition, we risk a second wave and we risk not benefiting from the health system changes that occurred during the pandemic. That would be another tragedy on top of the trauma caused by the pandemic itself.

Table of contents

Overview	3
Recommendations for coming out of lockdown	6
Recommendations for the health system	7
1 The nature of pandemics	9
2 The course of Australia's COVID-19 response	21
3 Coming out of lockdown	38
4 The health system after lockdown	53
A Modelling the spread of COVID-19 in Australia	67
B Simulation outcomes by state	87

List of Figures

1.1	Over the past 100 years, major infectious disease outbreaks have varied in scale and severity	11
1.2	The ‘pandemic curve’ scenarios	15
1.3	How a virus with a reproduction number (R_0) of 2 spreads	17
1.4	With exponential growth, Australia’s ICU capacity would have been reached quickly	19
2.1	The five phases of Australia’s response	22
2.2	Australia’s case numbers had slowed while they continued to increase in some comparable countries	26
2.3	Australia has one of the highest testing rates in the world	28
2.4	A timeline of Australia’s major COVID-19 policies	31
2.5	Nearly two-thirds of Australia’s COVID-19 cases have come from overseas	33
2.6	Australians have taken to telephone GP consultations during the COVID-19 outbreak	34
3.1	The stages of a COVID-19 infection	39
3.2	Super-spreading events	41
3.3	Efficient contact tracing reduces the risk of outbreaks	42
3.4	Australia is slowly reopening	43
3.5	Poor social distancing in open shops presents a severe risk	44
3.6	Reopening workplaces could pose big risks	46
3.7	Opening schools only increases risk of outbreaks slightly	47
A.1	Most new infections were from new arrivals, or coincided with the peak in overseas cases	69
A.2	The geometric distribution with mean 15 over [0, 50]	69
A.3	Incubation period	77
A.4	Meta-analysis of COVID-19 infection fatality rates	80
A.5	Imputed active cases	83
A.6	Comparing Grattan’s COVID-19 model with actual cases April-June	84
B.1	Social distancing efforts, by state	87
B.2	Reopening workplaces, by state	88
B.3	Opening schools, by state	88

Recommendations for coming out of lockdown

1. Maintain social distancing efforts while there are active COVID-19 cases locally

- Maintain high levels of testing, contact tracing, and isolation.
- Workplaces should be re-opened slowly, with as many people as possible continuing to work from home. Minimise the number of people interacting in workplaces where possible.
- Enforce social distancing in workplaces.
- Workers who show symptoms linked to COVID-19 must not be allowed to go to work. Their employers must allow them to work from home where possible. Governments should provide support for workers who do not have sick leave entitlements.
- Schools must be closed, and rigorous contact tracing implemented, whenever a COVID-19 case is detected at the school.
- Policies limiting patrons in shops should be maintained if local transmission of COVID-19 continues in particular cities.
- People in the community must continue to take social distancing precautions. Where there are active cases, the government should encourage people to wear masks in public.

2. Ramp up local lockdowns when outbreaks occur

- State governments must be prepared to reimpose lockdowns to control major outbreaks.
- Local lockdowns should be enacted to control local outbreaks.

3. When there are no active COVID-19 cases in Australia

- Capacity constraints on workplaces, shops, and hospitality can be removed. People can start to move freely within and between states.
- Testing must remain a routine part of life. If local cases are identified, contact tracers must be at the ready, and widespread testing should restart in affected areas.
- Current mandatory quarantining of people arriving from overseas must remain in place.
- Quarantine exemptions could be made with other countries, such as New Zealand, that also have no active COVID-19 cases and that have effective international arrival protocols in place.

Recommendations for the health system

The Commonwealth Government should:

4. Expand telehealth

- Introduce new general practice telehealth items to replace the pandemic ones, limited to patients with an established relationship to a practice, and in the case of people aged 70+, to the practice in which the patient is enrolled.
- Include requirements about e-mail consultations in the standards for practice eligibility.
- Introduce streamlined specialist telehealth items to facilitate secondary consultations with GPs (with or without the patient present).
- Introduce new specialist telehealth items for consultations other than the initial consultation.
- Introduce incentives for doctors to bulk-bill telehealth items, and subject them to strict electronic verification requirements.
- Fund the development of programs to close the digital divide.

5. Encourage outreach and telehealth with new primary care funding models

- Consider new funding models for general practice, to pay for more telehealth items.
- Review the barriers in the Medicare Benefit Schedule to practices reforming their workforce.

6. Make the system more efficient by connecting public and private

- Empower private health insurers to participate in funding diversion options so patients can have their rehabilitation at home rather than in a hospital.

State governments should:

7. Make the system more efficient by connecting public and private

- Negotiate contracts with private hospitals for elective procedures to be performed in these hospitals, to help clear the elective surgery backlog.
- Consider the same strategy to meet future demand for elective procedures.
- Develop agreed assessment processes for high-volume procedures, such as knee and hip replacements and cataract operations, and reassess all patients on hospital waiting lists.
- Use multidisciplinary teams to prepare care paths to ensure non-medical treatments are appropriately considered.
- Do not re-establish the full range of elective procedures in every hospital.

The Commonwealth and state governments should:

8. Expand out-of-hospital care

- States should expand hospital-in-the-home, rehabilitation-in-the-home, and outreach into residential aged care facilities.

- The Commonwealth should develop new Medicare Benefit Schedule items to facilitate telemonitoring and primary care outreach, limited to enrolled patients.
- The Commonwealth and the states should review public hospital funding to ensure it does not inhibit expansion of in-home services, services in residential aged care facilities, and telemonitoring.
- States with plans to expand public hospital bricks and mortar should assess whether it would be better to instead expand out-of-hospital and telehealth services.

9. Improve health system readiness by better planning

- Review governance approaches to the COVID-19 pandemic, and incorporate lessons learned into Australia's pandemic preparedness arrangements.
- Improve intensive care unit (ICU) strategies to prepare for surges in demand, and develop workforce strategies that enable quicker training of health workers, and deployment of workers from regions less-affected by a crisis.
- Develop a national surveillance strategy for the collection, analysis, and reporting of data at a national level.
- Boost programs for mental health care and to reduce domestic violence and drug and alcohol abuse.

10. Strengthen the supply chain

- States and territories – individually and collectively – should consider:
 - giving a greater price premium to local supply and manufacture;

- rewriting supply contracts to increase obligations on suppliers to ensure continuity of supply;
 - increasing product standardisation across the health system to allow easier substitution of products and to reduce the cost of inventory; and
 - increasing flexibility by spreading the supply chain across more than one supplier.
- The Commonwealth Government should regularly review the national 'stockpile' to ensure it contains the right mix of products.

11. Integrate regional planning and system management

- The Commonwealth should strike primary care agreements with each state.
- The Commonwealth and the relevant state government should strike tripartite agreements with every Primary Health Network around Australia.

1 The nature of pandemics

In 1947, Albert Camus aptly remarked: ‘Everybody knows that pestilences have a way of recurring in the world; yet somehow we find it hard to believe in ones that crash down on our heads from a blue sky.’¹

New infectious diseases frequently emerge throughout human history. In some cases, they can sweep across the world causing widespread illness, death, and disruption.² When a disease breaks out and rapidly spreads through a community, it can become an ‘epidemic’, and if it spreads worldwide and affects a large number of people simultaneously it becomes a ‘pandemic’.³

After emerging in China in late 2019, the novel coronavirus rapidly became a pandemic as it spread to nearly every corner of the globe by early 2020, making millions sick and causing hundreds of thousands of deaths. After first spreading to some Asian countries, Europe fast became the epicentre for the disease, followed by the United States, which by June had the highest number of cases in the world.

In the face of the pandemic, governments needed to manage three categories of risks: risk to health, risk to health systems, and risk to economic livelihoods. But many countries were not fully prepared to act fast enough and contain the rapidly spreading COVID-19.

Governments sought to introduce measures – to varying degrees and with varying effectiveness – to slow the spread of the virus. Many countries, including Australia, went into some degree of enforced lockdown. Shops, restaurants, and cafes closed, and people were asked or directed to stay at home. The skies cleared of planes, city

roads went quiet, and pollution lifted. These measures helped contain the virus and slow the spread. After reaching a peak in new cases, many countries, including Australia, have managed to keep the number of new cases down for now. And after enhancing response capabilities, measures could be slowly unwound. Other countries, such as the US, Brazil, and India, are struggling to contain the virus.

Now the world needs to adapt to a ‘new normal’, where the economic fallout continues, and the virus continues to pose a threat.

This report focuses on the epidemiological and health policy aspects of the COVID-19 crisis.⁴ This chapter summarises the key aspects of the COVID-19 pandemic by providing context on the emergence of infectious diseases, global preparedness for pandemics, and the risks that pandemics pose to communities.

1.1 The origins of pandemics

Pandemics can begin with the emergence of a new disease pathogen or variant. This can occur via genetic change or when transmission pathways of a pathogen change – or sometimes both at the same time.⁵ Disease pathogens can be viruses, parasites, fungi, or bacteria.⁶ Pathogens can be transmitted by water, air, food, or by contact with insects, animals, or humans.⁷

1. Albert Camus, ‘The Plague’, 1947.

2. Saunders-Hastings and Krewski (2016).

3. This is the classical definition of an influenza pandemic. Note that influenza pandemics can vary in terms of transmissibility and disease severity: Kelly (2011).

4. Note that this report accounts for events and evidence up until and including 1 June 2020.

5. For influenza, genetic change can occur via two mechanisms: reassortment, or mutation. Reassortment is the mixing of a human influenza virus with genes from a bird or animal virus. For example, the 1957 Flu came from the genetic reassortment of a bird virus. Genetic mutation is the change in the genes of an animal influenza virus. See Department of Health (2010).

6. Lindahl and Grace (2015).

7. National Institutes of Health (2007).

The emergence of new infectious diseases is driven by environmental, social, and economic change.⁸ In the past, new infectious diseases were often associated with urbanisation, population movement, and colonisation.⁹ More recently, rapidly increasing global trade, travel, environmental degradation, and climate change have altered disease pathways, potentially increasing the risk of pandemics and global transmission of diseases.¹⁰

Although most new viruses do not easily infect humans, when they do, they can pose a significant risk.¹¹ The danger to human populations then depends on the severity of the infection and how easily it can transmit between humans. For example, Middle East Respiratory Syndrome (MERS) kills about 30 per cent of people who catch it (often from camels), but human-to-human transmission is limited.¹² This was not the case for SARS-CoV-2,¹³ which causes the COVID-19 disease.¹⁴ It can easily transmit between humans, making it a significant threat to public health.

The emergence of COVID-19 disease was first documented in Wuhan, Hubei Province, China, but the exact origin of the virus is not yet known.¹⁵ It was originally suggested the virus may have jumped from bats or another intermediary animal to humans at a wet market

in Wuhan, but this is only one of a number of hypotheses.¹⁶ More research is needed to test these theories.¹⁷

1.2 The history of pandemics

Outbreaks of new infectious diseases vary in their scale and severity, and even in the modern world continue to pose a threat. The most famous pandemic, known as the Black Death, occurred in the 14th Century, killing between 30 per cent and 50 per cent of the European population within four years.¹⁸

Over the past 100 years, the world has experienced four influenza pandemics (see Figure 1.1).¹⁹ The 1918 Flu²⁰ caused about 50 million deaths, the 1957 Flu caused between one million and four million deaths, the 1968 Flu also caused between one and four million deaths, and the 2009 Flu caused between 200,000 and 300,000 deaths worldwide.²¹

8. Lindahl and Grace (2015).

9. Ibid.

10. Epstein (2001); and Lindahl and Grace (2015).

11. Department of Health (2010); and J. M. Hughes et al (2010).

12. World Health Organisation (2019); and Rafiq et al (2020).

13. The International Committee of Taxonomy of Viruses (ICTV) named the virus as SARS-CoV-2, because of the previously identified variant severe acute respiratory syndrome coronavirus (SARS-CoV): Rafiq et al (2020).

14. SARS-CoV-2 is a coronavirus. There are many of these viruses, including SARS-CoV and MERS-CoV: Gorbalenya et al (2020).

15. There is also some early evidence of COVID-19 spreading in France in December 2019 – one month before the first reported case in the country: Deslandes et al (2020).

16. Andersen et al (2020), F. Wu et al (2008) and Zhou et al (2012). This theory proposes that bats may have served as a reservoir host, and that Malayan pangolins sold at the wet market may have acted as an intermediary host before the virus was passed on to humans.

17. Most theories suggest that the virus originated in bats. Bats are a significant natural reservoir for coronaviruses. Bats have extremely active and competent immune systems for managing these virulent viruses. Coronaviruses that evolve in bats are therefore more likely to be dangerous for species with less powerful immune systems.

18. DeWitte (2014).

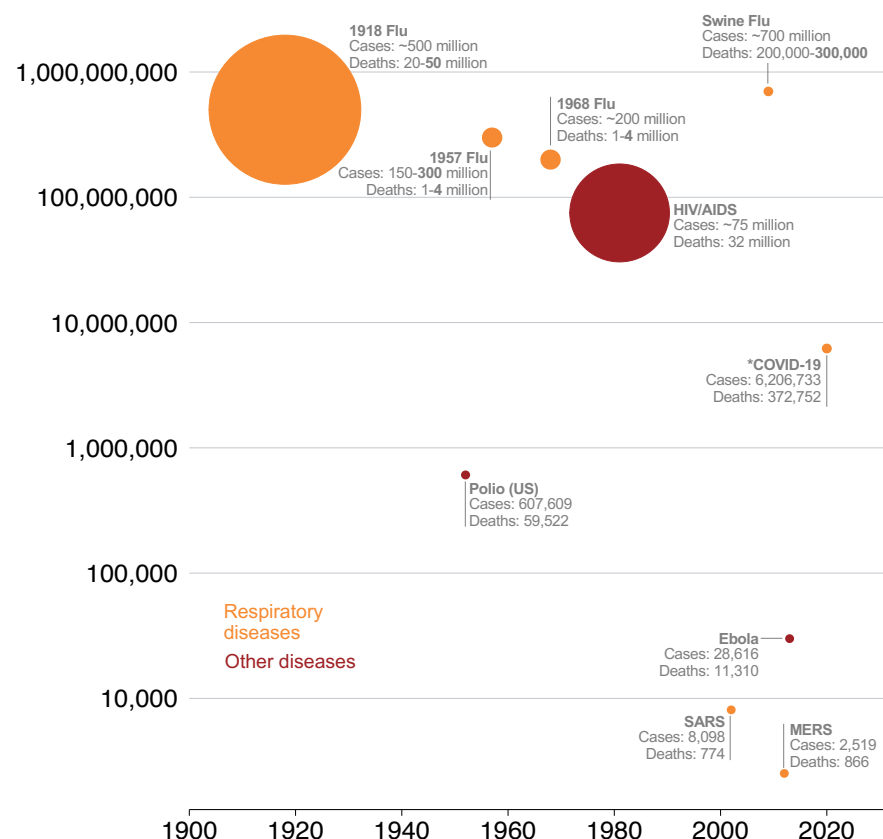
19. Influenza is a contagious disease of the respiratory tract caused by influenza viruses: Department of Health (2011). Other major non-influenza type pandemics that started in the 20th Century include HIV/AIDS, cholera, and polio.

20. Otherwise known as the 'Spanish Flu'. But the WHO has issued best practices in naming infectious diseases that minimise unnecessary negative effects: World Health Organisation (2015).

21. Rafiq et al (2020). Note that there is uncertainty about the total deaths related to Swine Flu. Rafiq et al (ibid) quote the lab-confirmed death toll at 18,631. But modelling in 2012 estimates that the death toll for respiratory deaths is more likely be 201,200 respiratory deaths (range 105,700 to 395,600): Dawood et al (2012).

Figure 1.1: Over the past 100 years, major infectious disease outbreaks have varied in scale and severity

Total number of infections (log scale) with death toll shown by bubble size.



Notes: The bubble size is indicative only and not exactly proportional due to a minimum bubble size. Case numbers are estimations only. The bubbles are located at the start date of the pandemic, noting that some pandemics, such as HIV/AIDS, peaked about 20 years later. Polio is an exception, because it came in waves across the first half of the 20th Century. The 1957 Flu case number is calculated using an 0.67% CFR and assuming 1-2 million deaths, to arrive at 150-300 million cases (Nickol and Kindrachuk (2019)). The 1968 Flu case number is calculated from an 0.5% CFR and assuming 1 million deaths, which amounts to about 200 million cases (Sino Biological (2020)). The Swine Flu case number is calculated by assuming an 11% (lower bound) total population infection rate from Kelly et al (2011) to bring the number to 700 million (upper bound was 21%). *COVID-19 numbers as at 1 June 2020.

Sources: Data on 1918 Flu: Rafiq et al (2020) and Centers for Disease Control and Prevention (2019). Data on Polio: Ochmann and Roser (2017). Data on 1957 Flu: Rafiq et al (2020) and Nickol and Kindrachuk (2019). Data on 1968 Flu: Rafiq et al (2020) and Sino Biological (2020). Data on HIV/AIDS: World Health Organisation (2018). Data on SARS: Centers for Disease Control and Prevention (2017). Data on Swine Flu: Dawood et al (2012), Simonsen et al (2013) and Kelly et al (2011). Data on MERS: World Health Organisation (2020a). Data on Ebola: World Health Organisation (2016). Data on COVID-19: Johns Hopkins Coronavirus Resource Center (2020).

Several recent respiratory disease epidemics, including COVID-19, have been caused by coronaviruses. Coronaviruses are a type of virus that can cause illnesses ranging from the common cold to severe acute respiratory syndrome.²² In 2003, the Severe Acute Respiratory Syndrome (SARS) epidemic infected 8,098 people, mainly in China and South-East Asia, and caused about 774 deaths.²³ In 2012, the MERS epidemic emerged in Saudi Arabia and spread to 27 countries.²⁴ MERS has infected 2,519 people and has caused 866 deaths to date.²⁵

Each epidemic or pandemic runs its own course. Pandemics can also have second and third waves of infection, such as the 1918 Flu.²⁶ The diseases are then often here to stay, continuing to circulate in the community. But they may not continue to pose a significant threat if a vaccine or treatment is developed.²⁷

1.3 Global pandemic preparedness

Since the 1960s there has been much less focus on the possibility of major infectious disease outbreaks.²⁸ But a renewed global focus

on pandemic preparedness began after the 2003 SARS epidemic, which brought increased attention to the need to be better prepared for new infectious diseases.²⁹ This helped with a more coordinated global response to Swine Flu in 2009,³⁰ but the 2014 Ebola epidemic exposed further gaps in preparedness.³¹

A newly established UN Panel on the Global Response to Health Crises noted in 2016 that ‘the high risk of major health crises is widely underestimated, and that the world’s preparedness and capacity to respond is woefully insufficient’.³² The Panel made 27 recommendations to improve global preparedness and concluded that ‘future pandemic threats will emerge and have potentially devastating consequences. We can either take immediate action to ensure that future threats are contained, and humanity is protected, or we will remain vulnerable to losing millions of lives and suffering devastating social, political and economic consequences’.³³

Experts have called for a boost in health sector capacities, investment in research and development, improved national preparedness systems, financial risk planning, and global coordination.³⁴

And 2013 modelling done as part of a WHO group estimated that there were between 123,000 and 203,000 deaths during the main pandemic wave in 2009: Simonsen et al (2013).

22. World Health Organisation (2020b).

23. World Health Organisation (2012); and Centers for Disease Control and Prevention (2017).

24. World Health Organisation (2019).

25. World Health Organisation (2020a).

26. Saunders-Hastings and Krewski (2016).

27. Madhav et al (2017).

28. See McKeown (2009) and Spellberg and Taylor-Blake (2013). There have been some exceptions. The HIV-AIDS pandemic in the 1980s resulted in a very significant effort to prevent transmission that has only lessened with the development of effective anti-retroviral treatment. But public health planning in highly industrialised countries such as Australia has focused more on chronic disease management and prevention. See more about Australia’s disease burden at Australian Institute of Health and Welfare (2015).

29. Madhav et al (2017). The delayed reporting of the SARS outbreak in some countries resulted in the WHO updating the International Health Regulations to require countries to meet standards for reporting and managing outbreaks. But progress towards meeting these standards has been uneven across countries.

30. Katz (2009).

31. Madhav et al (2017). Following Ebola, the WHO also discovered limitations to the self-reporting system under the 2005 International Health Regulations, as many countries in the region were less prepared to manage the disease than self-reported. In 2016, the WHO created an enhanced monitoring and evaluations tool to review the WHO member states’ compliance with the International Health Regulations: Bell et al (2017).

32. Kikwete et al (2016, p. 5).

33. Ibid (p. 8).

34. Yamey et al (2017); and Global Preparedness Monitoring Board (2019, pp. 7–10).

A September 2019 report by the Global Preparedness Monitoring Board for global health risks,³⁵ lamented that the global pandemic response typically cycled through panic in the face of a threat, followed by neglect once a crisis was forgotten.³⁶ It noted that if the past is prologue, ‘then there is a very real threat of a rapidly moving, highly lethal pandemic of a respiratory pathogen killing 50-to-80 million people and wiping out nearly 5 per cent of the world’s economy’.³⁷ Within months, COVID-19 emerged.

While COVID-19 has been successfully contained in several countries, many countries did not respond fast enough or effectively enough. This meant that COVID-19 quickly spread out of control, particularly in Europe, the US, and now South America.³⁸

Australia drew on its pandemic preparedness regime, which had largely been established since SARS in 2003 and further improved since Swine Flu in 2009.³⁹ The state governments have emergency public health response plans, and the Commonwealth Government has an Australian Health Pandemic Plan for Pandemic Influenza

and a National Medical Stockpile.⁴⁰ The Australian Health Protection Principal Committee (AHPPC), which is made up of chief health officers of each state and territory and the Commonwealth, also provides health advice to decision makers. But COVID-19 revealed some key gaps in Australia’s preparedness for a crisis of this scale (see Section 2.2.2 and Section 4.5).

1.4 The three major risks of a pandemic

An outbreak of a new disease can damage human health, and depending on its infectiousness and severity, can put a significant burden on health systems. These risks, combined with the consequent measures to slow the spread of a disease, have flow-on economic effects. Governments must manage these three risks in combination – not as trade-offs, but as inter-related issues.⁴¹ Governments can best minimise these three risks by treating them as a whole; a more effective public health response to reduce the spread of a virus means a reduced burden on hospitals, and a reduced burden on the economy in the longer term.

1.4.1 Risk to health

Infectious diseases cause illness – each with its own symptoms and severity. After about six months, COVID-19 has made more than six million people sick globally, causing nearly 400,000 deaths.⁴² Australia has suffered less than many countries; there have been about 7,200 cases, including 103 deaths.⁴³

35. The board is co-convened by the WHO and the World Bank Group and was created in 2018 to build on the work of the UN’s Global Health Crises Panel: Global Preparedness Monitoring Board (2018, p. 4).

36. Global Preparedness Monitoring Board (2019, p. 6); and Yamey et al (2017).

37. Global Preparedness Monitoring Board (2019, p. 6). The 2019 Global Health Security Index report also found that ‘no country is fully prepared to handle an epidemic or pandemic’: Cameron et al (2019, p. 9). The Global Health Security Index score for pandemic preparedness was 40.2 out of 100. Australia had the fourth highest overall score at 75.5. But the US had the highest ranking, which suggests the Index may not be very indicative of actual preparedness and response capability.

38. Countries, particularly in East Asia, that had more recently experienced epidemics, such as the SARS epidemic in 2003 and H1N1 influenza in 2009, appeared to respond more successfully to COVID-19. For example, Taiwan had fewer than 500 cases and fewer than 10 deaths four months after its first case.

39. Brew and Burton (2004, pp. 12–13); and Department of Health and Ageing (2011).

40. The Emergency Response Plan for Communicable Disease Incidents of National Significance: National Arrangements (National CD Plan) also provides guidance on national coordination for non-health government agencies.

41. See more on this issue in Grattan Institute’s forthcoming report: ‘The Recovery Book: what Australian governments should do now’.

42. As at 1 June 2020: Johns Hopkins Coronavirus Resource Center (2020).

43. As at 1 June 2020: Department of Health (2020a).

The nature of COVID-19

SARS-CoV-2 is a new coronavirus, which means humans are likely to have no natural immunity to it, making everyone potentially susceptible to COVID-19 disease.

Most people who get COVID-19 experience a mild-to-moderate respiratory illness and recover without needing special treatment.⁴⁴ Some people, especially younger people, may not even experience any symptoms. Children appear less likely to get COVID-19, and less likely to spread it to others (see more in Appendix A.10).⁴⁵

But COVID-19 is a virulent disease, with the severity of the illness tending to increase with the person's age; older people, and those with underlying health problems, are more at risk (see more in Appendix A.9.2). And about 1 per cent of people who get it die (see Appendix A.9.3).⁴⁶

Much is still not known about COVID-19, making it difficult to manage the risk – both for health professionals and governments. New research about the virus and its symptoms is rapidly evolving.⁴⁷

Reducing the health risk

There is currently no vaccine for COVID-19. Medical researchers around the world have developed about 120 potential candidates (as

at 1 June 2020).⁴⁸ Any that are finally produced for widespread use will need to go through a rigorous trial process first.⁴⁹ Most are still in the preclinical phase. About 10 are being tested with small groups of people to check their safety and to see whether they have the desired immune response.⁵⁰

Despite the unprecedented international effort to develop an effective vaccine, there is no certainty of success.⁵¹ Trials will need to assess a range of outcomes including the extent of protection; how long protection lasts; whether children, adults, and older people are equally protected; and major and minor adverse effects.⁵² Most new vaccine candidates fail to demonstrate enough immune protection during early trials. Others fail because they are unsafe.⁵³ When a vaccine is found to be effective and safe, production and distribution have to be scaled up for widespread use in the population. It is therefore unlikely that a vaccine will be generally available for at least 12 months.⁵⁴ Even this timeline would require vaccine development to move at unprecedented speed, because this process usually takes about 10 years.⁵⁵

There is also currently no effective treatment for COVID-19, with clinicians aiming to manage symptoms of the disease. New research is being conducted to try and find treatments for the disease.⁵⁶ A number of agents – both natural and artificial – have shown some potential

44. See Appendix A.9 on page 78 for a discussion of COVID-19 patient outcomes.

45. See also a Grattan Blog post on this issue: Duckett and Mackey (2020a).

46. Verity et al (2020).

47. For example, recent research shows that COVID-19 can affect the endothelial cells that line blood vessels and protect the cardiovascular system – suggesting it may be more than just a respiratory illness: Varga et al (2020). This could help explain other recent evidence that the virus causes a much broader set of problems than originally understood, including blood clots, strokes, problems with digestion, joint pain, abdominal pain, vomiting, and diarrhoea: Docherty et al (2020).

48. World Health Organisation (2020c).

49. Singh and Mehta (2016).

50. One, the University of Oxford/AstraZeneca candidate, is in the third phase of testing for any adverse effects and its effectiveness in preventing COVID-19 with 10,260 participants in the trial: N. P. Taylor (2020). It will take between two and six months to see whether the vaccine is effective and safe.

51. Vaccines have not been developed for other types of coronaviruses: Kahn (2020).

52. N. Lee and McGeer (2020).

53. Fogel (2018).

54. Swerissen (2020); and Thanh Le et al (2020).

55. Thanh Le et al (2020).

56. Rafiq et al (2020).

effectiveness against COVID-19. Numerous potential antiviral drugs, including Hydroxychloroquine, Lopinavir/Ritonavir, and Remdesivir, are going through trials.⁵⁷ At best these treatments are likely to only partially reduce illness and death from COVID-19.⁵⁸

Without a vaccine or effective treatments, and without any measures to reduce transmission between people, a disease can rip through a community (the 'uncontrolled scenario' in Figure 1.2 and see Box 1). It would continue transmitting – first rapidly and then more slowly – until it infects a large majority of people in the population to build 'herd immunity' (estimated to be between 60 per cent and 70 per cent of the population for COVID-19).⁵⁹ This means the infection rate would then slow because there are insufficient susceptible people for increased transmission. Over time, herd immunity would diminish the incidence of the disease.

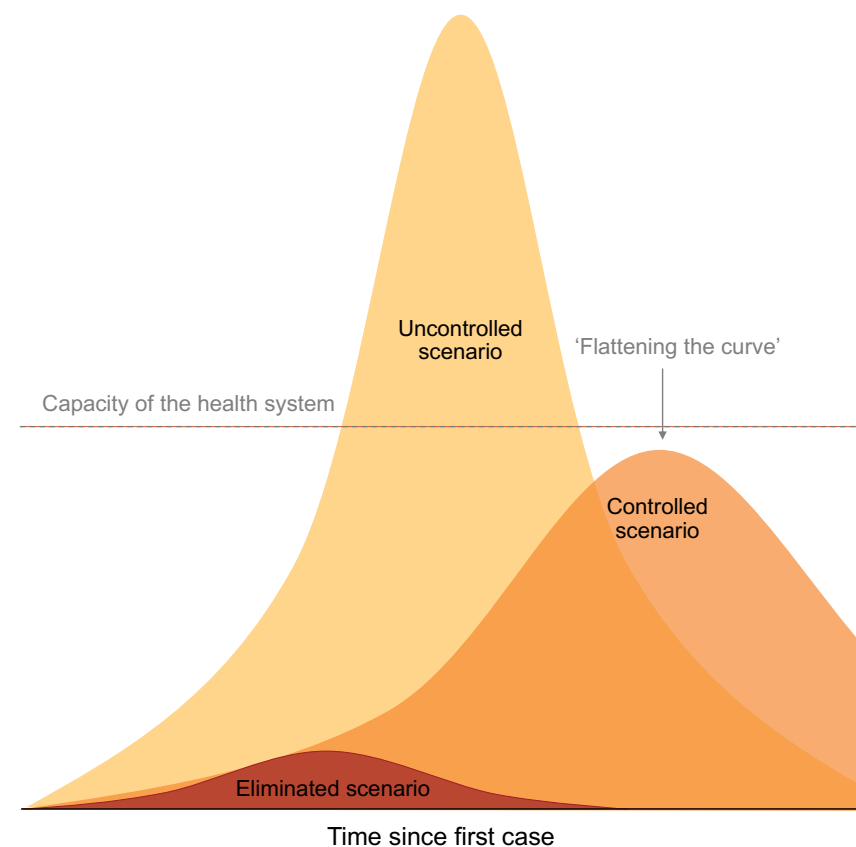
But governments can avoid the uncontrolled scenario by using public health interventions to slow the spread of a virus. Interventions seek to reduce the rate of transmission – to 'flatten the curve' (the 'controlled

57. Ibid.

58. The anti-tuberculosis BCG vaccine may have potential to reduce COVID-19 infections. The BCG produces a stronger innate immune response to a range of infectious diseases and may have a protective effect for COVID-19, but trials are only just beginning: Slessor (2020).

59. The threshold for 'herd immunity' is calculated as: $\text{herd immunity} = 1 - 1/R_0$: Randolph and Barreiro (2020). The 60 per cent to 70 per cent figure is based on an R_0 of 2.5 to 3 for COVID-19 and assumes homogenous spread of the disease: Gabriela et al (2020). But note that some papers have indicated that developing herd immunity naturally (rather than via a vaccine) means that the threshold may be lower, because it involves heterogeneous spread: Britton et al (2020) and Gabriela et al (2020). For example, Britton et al (2020) calculated it to be about 43 per cent. In addition, herd immunity only works if infection results in immunity and the immunity lasts. Although early evidence shows that immunity is conferred for COVID-19, it is unclear how long immunity to COVID-19 lasts after infection. Some early research shows it lasts at least one month, and looking at the previous SARS disease, could persist for several months to two years: Randolph and Barreiro (2020).

Figure 1.2: The 'pandemic curve' scenarios
Number of new cases



Source: Adapted from *The Economist* (2020).

scenario' in Figure 1.2 and see Box 1). And after reaching a lower peak than the 'uncontrolled' scenario, it should begin to decline again if the rate of transmission (R_{eff}) is kept low.

There are several public health interventions that can reduce spread of a disease. They include case identification and contact tracing, such as testing and isolating confirmed cases (see more in Chapter 3). They also include social distancing measures, such as banning gatherings of people, requiring people to stay at home, closing schools, and so on.⁶⁰ It is not only the types of interventions, but also the timing that determines their effectiveness.⁶¹

But unless these interventions are able to effectively eliminate the virus in a country, the virus is still likely to make many people sick from the disease – but at a slower rate and over a longer period, if some interventions remain in place. The benefit of 'flattening the curve' (the 'controlled scenario') is that the health system is not overwhelmed, meaning that people can get better treatment, and there will probably be fewer deaths or severe illness. It also means that the health system is still able to adequately treat people who have other health problems.⁶²

Another option is to 'eliminate' the virus all together (See 'eliminated scenario' in Figure 1.2).⁶³ Although elimination may not be an option for countries with high case numbers and/or land borders with other

nations, Australia, like New Zealand and Taiwan, may have a chance. This may be achieved if infection rates are so low that each remaining case and their close contacts can be isolated and controlled.⁶⁴

Secondary health effects

A health system focused on responding to a pandemic can struggle to adequately care for people with other health problems. For example, the re-allocation of resources towards COVID-19 in Australia resulted in the suspension of non-urgent elective surgeries. And significantly fewer people than usual sought medical treatment including for preventive care consultations such as cervical cancer screening,⁶⁵ because they were concerned that they may put themselves at risk at a health clinic or hospital or unnecessarily burden the health system,⁶⁶ or because services were suspended.⁶⁷

Widespread job losses, financial difficulties, and changes to everyday life created by lockdowns, including forced closure of businesses, travel restrictions, and social distancing, all have flow-on effects, and risk increasing health inequities.⁶⁸ They can trigger or exacerbate mental health problems.⁶⁹ Mental health hotlines in Australia have reported a 25-to-50 per cent increase in the number of calls received, compared to the same time last year.⁷⁰

64. See Plank et al (2020).

65. Outcome Health (2020a).

66. Cunningham (2020a). These trends were also seen elsewhere. For example, in Italy, a study found that substantially fewer children were seeking medical treatment – up to 88 per cent fewer children went to emergency departments compared to the same time in the previous year: Lazzarini et al (2020).

67. For example, routine screenings for breast cancer were suspended in NSW: Raper (2020).

68. The flow-on health, social and economic effects of the pandemic are not felt equally by different groups. Homeless people, for example, are particularly vulnerable: Barneveld et al (2020, pp. 4–6).

69. Xiang et al (2020); and Torales et al (2020).

70. Morrison (2020a).

60. We use the common term 'social distancing' in this report, in line with epidemiological literature. But we recognise that the actual aim is spatial or physical distancing, and that using the term 'social distancing' may imply that meaningful social interactions should be cut off, when in fact they need to be maintained: Bavel et al (2020, Box 1).

61. See for example Hollingsworth et al (2011).

62. See more at Section 1.4.2 on risk to health systems.

63. Note that we define 'elimination' as keeping cases very low so as to be effectively eliminated. This can occur in defined geographical areas. This is different to 'eradicate', which means a permanent reduction to zero of the worldwide incidence of the disease: Dowdle (1998).

Box 1: The language of pandemics – ‘ R_0 ’

R_0 , pronounced ‘R naught’, is an epidemiological term to describe the rate of transmission of a disease in a totally susceptible population. Technically, it is known as the basic reproduction number, where R is for reproduction, and 0 is for patient zero.^a

The R_0 is the average number of infections to stem from a single case (assuming the whole population is susceptible and there is no immunity or any interventions in place).^b For example, if an R_0 is 2, then one person with the disease is expected to infect two others, and so on (Figure 1.3). The Department of Health most recently estimated the R_0 for COVID-19 at about 2.5.^c

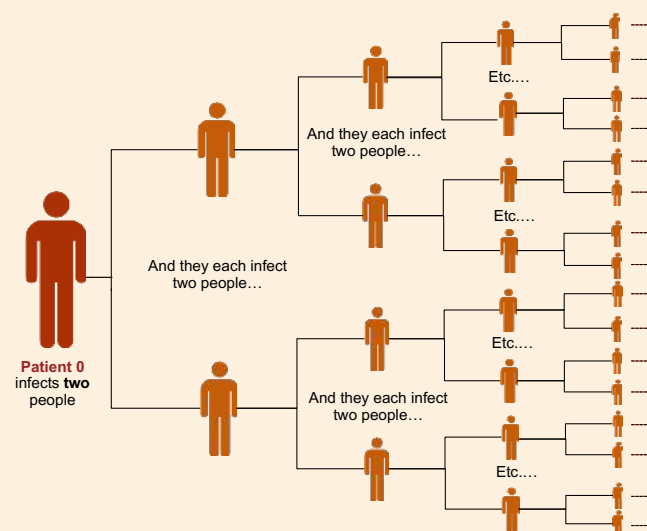
R_0 is useful in determining the intensity of an infectious disease outbreak.^d A high R_0 means that the disease is likely to rapidly spread through a community. For example, the R_0 for measles ranges from 12 to 18 – showing that measles is a highly infectious disease.

But R_0 is often misrepresented or misinterpreted, because it is determined by a complex set of factors including the properties of the disease pathogen itself, and also biological, socio-behavioural, and environmental factors.^e

The ‘effective’ reproduction (R_{eff}) is used to describe the transmissibility at a given time. The R_{eff} is useful in determining whether public health

interventions are having an effect. Effective COVID-19 interventions, such as lockdowns, can reduce the R_{eff} over time. If the R_{eff} is greater than 1, then the rate of new cases is growing. If the R_{eff} is less than 1, then the rate of new cases is decreasing.^f

Figure 1.3: How a virus with a reproduction number (R_0) of 2 spreads



Source: Adapted from Eisenberg (2020).

- a. Eisenberg (2020). See also Delamater et al (2019).
- b. Becker et al (2006, p. 6).
- c. Department of Health (2020a).
- d. Eisenberg (2020).
- e. Delamater et al (2019).
- f. Ibid.

There are also risks of increased alcohol and drug abuse.⁷¹ And early reports show an increase in online gambling. Data from NAB shows that expenditure on online gambling is up by 50 per cent since the start of the year.⁷²

Lockdowns, job losses, and financial strain also increase the risk of domestic violence.⁷³ There are signs of increasing domestic violence during the COVID-19 pandemic. The number of online searches on Google for domestic violence help leapt during the pandemic.⁷⁴ There were 11 per cent more calls to the domestic violence crisis support-line 1800 RESPECT compared to the same time last year.⁷⁵

1.4.2 Risk to health systems

At their extreme, pandemics can threaten the viability of health systems. Under the ‘uncontrolled scenario’, a health system could be at risk of collapse. As many people get sick very quickly, pressure builds on hospitals.

The main purpose of flattening the curve is to avoid overwhelming a health system’s capacity, as shown in Figure 1.2.

There are limits to a health system’s capacity: the number of beds and intensive care units (ICUs), the size of the workforce, and supplies of personal protective equipment (PPE), ventilators, and medications. While purchasing more resources is fairly easy (provided there are reliable supply chains), rapidly increasing the workforce – particularly highly trained health professionals for ICUs – is harder. As a pandemic

escalates, the number of health workers may also diminish, because working in a high-risk setting makes them more likely to become infected with the disease (particularly if PPE is in short supply),⁷⁶ and suffer mental health problems.⁷⁷ Ramping up health sector capacity is also very costly, with governments needing to boost healthcare expenditure on PPE, hospital and ICU beds, ventilators, workforce, mental health support, and testing and contact tracing.⁷⁸

Once COVID-19 spread beyond China, Italy was one of the first countries to have a high number of confirmed cases. The virus spread quickly in the community, growing at such a rate that the number of people needing hospital treatment began to overwhelm the health system’s capacity. In the most-affected regions of Italy, the health system was close to collapse.⁷⁹ Hospitals were faced with difficult decisions about how to prioritise care.

At the peak of the crisis in Australia, in late March 2020, when the vast majority of cases were coming from overseas, Australia’s cases were doubling every 3-to-4 days. Without any effective interventions, and assuming the disease would follow the same pattern as other countries, there was a risk Australia’s ICU capacity would be overwhelmed by mid-April (see Figure 1.4).⁸⁰

71. Australian Government (2020, p. 24).

72. Wright (2020).

73. See for example Usher et al (2020), Bradbury-Jones and Isham (2020), and Renzetti (2009).

74. Morrison (2020b).

75. Australian Government (2020, p. 10). This figure is based on Department of Social Services data, 28 April 2020. See also Cormack (2020).

76. For example, during the early stages of the crisis in Italy (between 20 February and early March 2020) about 20 per cent of responding healthcare workers were infected with COVID-19: The Lancet (2020a). Some of those infected died.

77. Lai et al (2020). Mental health problems were also seen in Beijing healthcare workers after the SARS epidemic: P. Wu et al (2009). Shortages of PPE can also increase anxiety and stress for frontline healthcare workers: Edith Cowan University (2020).

78. For example, in 2019, the daily cost of a patient in ICU was over \$4,000: Hicks et al (2019).

79. Armocida et al (2020).

80. In April, Australia had about 2,400 ICU beds: Senate Select Committee on COVID-19 (2020a, p. 17).

But by the end of March, the Australian Government's border closures, contact tracing and isolation, and lockdown measures began to have an impact and slow the rate of new cases (see more in Chapter 2). These significant public health interventions meant that Australia very quickly turned a corner; the growth rate fell to merely 5 per cent per day by the start of April.⁸¹ Australia's case numbers have remained low ever since, and at this rate, Australia's healthcare system is not currently under threat.

1.4.3 Risk to the economy

The risk of global health crises goes far beyond health and health system costs; the short- and long-term economic costs are also significant. The economic costs often affect many more people than the underlying disease.⁸²

The economic costs of global pandemics stem from multiple and interrelated causes. The flow-on costs of public health interventions – such as shutting down businesses and requiring people to stay at home – are significant. Many people's livelihoods are cut-off, as businesses struggle to survive. This requires governments to increase debt, as they try to buffer some of these effects. For example, Australia's federal government has committed nearly \$150 billion against the coronavirus crisis so far (see more in Chapter 2).

In 2016, economists warned that pandemics could cause an average annual economic loss of 0.7 per cent of global GDP, or \$570 billion each year, in coming decades.⁸³

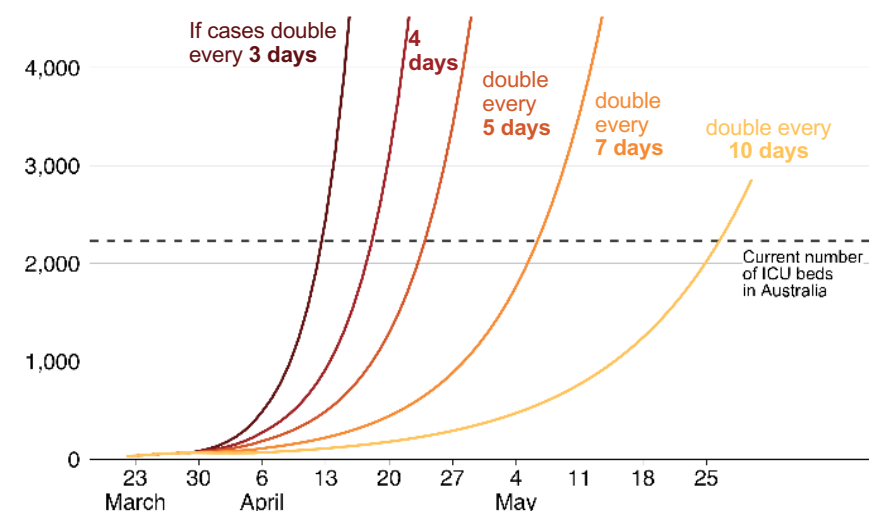
81. Duckett and Mackey (2020b), see the second chart.

82. Kikwete et al (2016, p. 29).

83. Fan et al (2016) noted that this is similar to the estimated cost of climate change. A Lowe Institute study in 2006 had similar findings on the cost of pandemics, but noted that the scale of the pandemic determines the extent of economic loss: McKibben and Sidorenko (2006).

Figure 1.4: With exponential growth, Australia's ICU capacity would have been reached quickly

ICU bed demand from COVID-19 under different growth scenarios from 23 March, 2020



Note: Assuming an average length of stay of eight days.

Source: Grattan analysis of data collated by Evershed et al (2020).

The World Bank in June said that the COVID-19 crisis is the worst economic downturn since World War II, with projected global growth in 2020 expected to fall by about 5 per cent.⁸⁴

In March, the Organisation for Economic Co-operation and Development (OECD) estimated there would be a 22 per cent hit to Australia's economy directly as a result of the shutdowns. The hit will probably be even worse once the effects on other sectors are considered.⁸⁵ The Reserve Bank of Australia (RBA) forecast a 20 per cent drop in total hours worked over the first half of 2020.⁸⁶ Unemployment is also expected to rise to 10 per cent in the June quarter.⁸⁷ Some people are economically worse off than others. Young people (aged 15 to 24) and women are disproportionately affected.⁸⁸ In June 2020 the Federal Treasurer announced that Australia was in recession.⁸⁹

Governments can minimise the damage caused by a pandemic, through economic support packages and other health, social, and fiscal policies that help carry the community through and out of the crisis.⁹⁰

1.5 Moving forward in uncertainty

Australia has been remarkably successful in managing the virus to date (see Chapter 2). But as Australia moves out of the emergency phase and towards a 'new normal', there are still many uncertainties.

It is uncertain whether there will be a second wave or resurgence of infections. It is uncertain whether Australia can eliminate the virus. It is uncertain how large the economic effects will be. It is uncertain when border restrictions can be lifted. It is uncertain if there will ever be a vaccine.

Governments can help, by investing in research and learning the lessons from this pandemic. This includes developing policies that best manage further outbreaks (see Chapter 3) and developing policies that strengthen Australia's healthcare systems (see Chapter 4).

84. World Bank (2020).

85. Coates (2020).

86. Lowe (2020).

87. Lowe (2020); and Ha et al (2020).

88. Australian Bureau of Statistics (2020a). Grattan Institute has published a working paper on the estimated employment shock of COVID-19 in Australia: Coates et al (2020, p. 22).

89. Frydenberg (2020a).

90. Grattan Institute will soon publish 'The Recovery Book: what Australian governments should do now', which includes policy recommendations on how to come out of the crisis.

2 The course of Australia's COVID-19 response

Australia's response to the COVID-19 pandemic has been remarkably successful. After an exponential increase that peaked at more than 400 cases a day in late March 2020, many coming from overseas, daily cases fell to less than 20 a month later (see Figure 2.1). At the same time, rapid growth in infections in almost every other comparable country threatened to overwhelm their health systems (Figure 2.2).

This chapter charts what happened, what was successful, and where Australia could have done better.⁹¹ These lessons should inform the next stage of Australia's response (see Chapter 3), and how Australia can strengthen its healthcare system (Chapter 4).

2.1 What happened

In late December 2019, China notified the World Health Organisation (WHO) of a mysterious pneumonia cluster.⁹² The disease that was to be named COVID-19 made its way into history. Cases in Hubei province grew exponentially: seemingly slow at first, then very rapidly from late January 2020.

The Chinese Government responded on 23 January 2020 with a massive program of testing, contact tracing, and quarantining of people likely to be infected. The population of Hubei was required to follow stringent social isolation. Travel, industry, education, recreation, and social gatherings were severely restricted to prevent the spread of infection.⁹³

The virus spread internationally in mid-January 2020, first to Thailand and then to South Korea, Japan, Singapore, and beyond.⁹⁴

On 30 January 2020, the WHO declared the coronavirus a global Public Health Emergency, when China's death toll reached 170, 7,711 cases had been reported in the country, and the virus had spread to at least 18 other countries.⁹⁵ Daily cases in China peaked at nearly 4,000 in February and then declined to less than a 100 a day by early March.

2.1.1 Australia's five-phase response

Australia's response to the pandemic passed through four phases: containment, reassurance amid uncertainty, cautious incrementalism, and escalated national action. Australia is now in the fifth phase: transition to a new normal (Figure 2.1). See Figure 2.4 for a summary of Australia's major COVID-19 policies in each phase.

Phase 1: Containment

Australia recorded its first case on 25 January 2020, less than a month after the early cases were reported in China.⁹⁶ During the early period of infection in Australia, the Commonwealth Government took main responsibility for managing COVID-19, acting on the advice of the Commonwealth Chief Medical Officer and the state and territory chief public health officers meeting as the Australian Health Protection Principal Committee.

The initial Commonwealth Government response was primarily focused on containing the external threat presented by the virus. During

91. The information in this chapter is largely drawn from Grattan Institute's Coronavirus Announcements Tracker: Stobart et al (2020).

92. World Health Organisation (2020d).

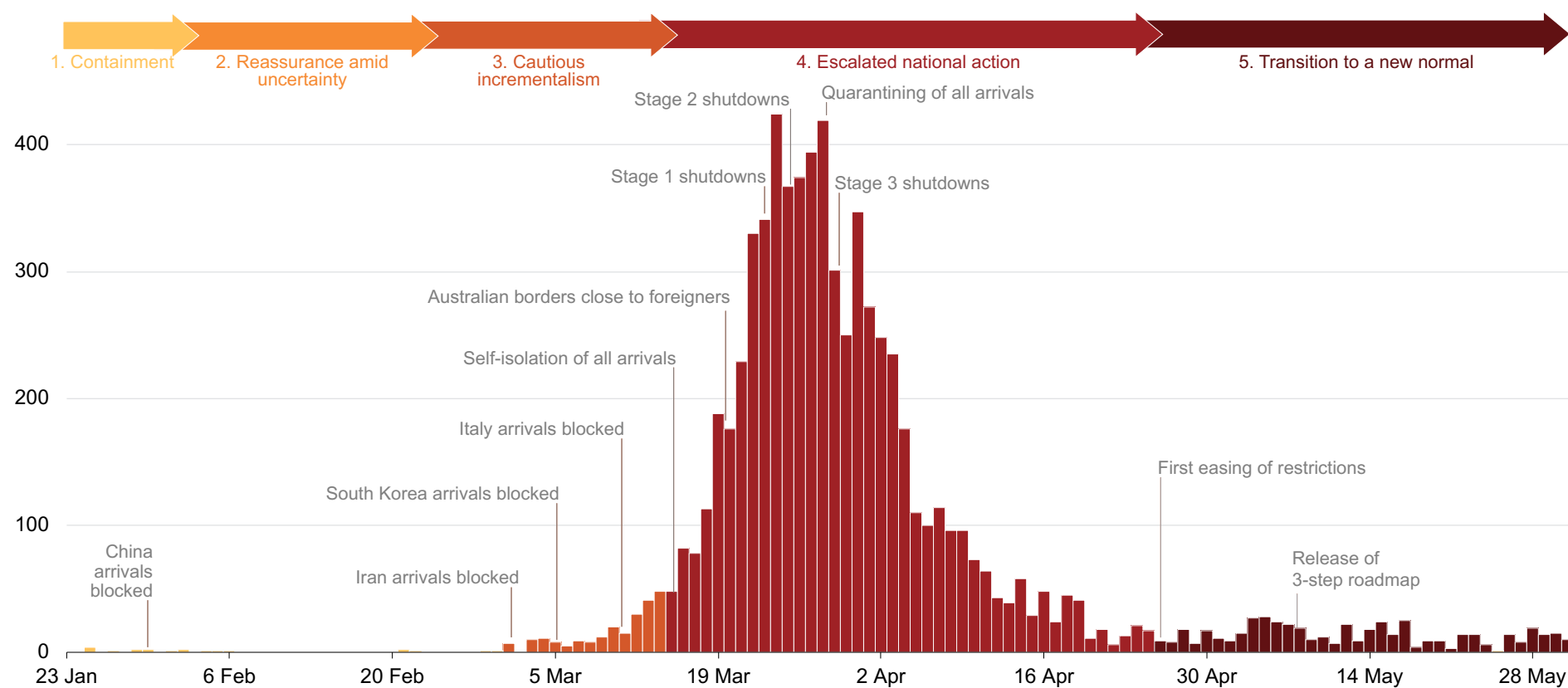
93. C. Wang et al (2020).

94. World Health Organisation (2020e).

95. World Health Organisation (2020f).

96. Hunt (2020a).

Figure 2.1: The five phases of Australia's response
Daily new COVID-19 cases in Australia by response phase



Notes: Only major lockdown events shown in grey. Data current as at 1 June 2020.

Source: Grattan analysis of data collated by Evershed et al (2020).

late January and early February 2020, Australia's first coronavirus cases were linked to travellers who had spent time in Wuhan, or had close contact with someone from Wuhan.⁹⁷ The Commonwealth Government focused its efforts on screening arrivals from China and evacuating vulnerable Australians out of Hubei province to designated, well-controlled quarantine facilities in Australia (such as Christmas Island).

As the virus rapidly spread in China to more than 10,000 confirmed cases by 1 February 2020, Australia moved quickly – earlier than other countries – to ban foreign nationals entering the country from China. It also required Australians travelling home from China to self-isolate for 14 days.

Phase 2: Reassurance amid uncertainty

After introducing travel restrictions from China, the Commonwealth Government did not take any significant steps until late February 2020. Instead, February was marked by uncertainty about the scale of the crisis, while the Government sought to reassure Australians by downplaying the risks.

With the exception of the outbreak of cases affecting Australians on the Diamond Princess cruise ship stranded in Japan, very few Australians contracted COVID-19 during February 2020. At the same time, it appeared the major outbreak in Hubei had subsided and the number of cases in other countries remained low.

There was uncertainty about the susceptibility, incubation, duration, transmission, morbidity, and mortality of COVID-19. Data and research were changing rapidly, on almost a daily basis. In the absence of clear data and analysis, there was concern about the potential social and

economic cost of widespread action to prevent the possible spread of infection.

On 18 February, the Commonwealth Government released the *Australian Health Sector Emergency Response Plan for Novel Coronavirus COVID-19*, which characterised COVID-19 as a significant risk to Australia, emphasised a 'proportionate response' to the risk, and did not contemplate closure of international borders.⁹⁸

Australia's response was reinforced by advice from the WHO. Although the WHO declared a Public Health Emergency at the end of January 2020, it did not consider travel or trade restrictions necessary.⁹⁹ The WHO emphasised containment based on detection, isolation, contact tracing, and information. It did not recommend mandatory quarantine of international travellers. Nor did it advise member countries to prepare broader social distancing measures and increase the capacity of their health systems, despite the experience in Hubei.

Australia's Prime Minister, Health Minister, and Chief Medical Officer rejected calls for extended travel bans and tighter quarantine for overseas travellers. Meanwhile, state and territory governments mainly continued business as usual, with the NT and Queensland launching international tourism campaigns after the summer bushfire crisis.¹⁰⁰

Yet COVID-19 cases were rapidly spreading in countries beyond China. South Korea had more than 1000 cases by 26 February 2020, Italy exceeded this number three days later, and Iran reported a doubling of its cases overnight to reach 1000 cases on 2 March 2020. By this time, the virus had spread to at least 75 countries worldwide.¹⁰¹

98. Department of Health (2020b, pp. 2, 40, 42).

99. World Health Organisation (2020g).

100. Lawler (2020); and Palaszczuk and Jones (2020).

101. Morrison (2020c).

97. Hunt (2020b).

Amid the uncertainty, the Prime Minister sought to reassure Australians in early March 2020 that they could ‘go about their daily interactions’, and that he was ‘looking forward to getting to places of mass gathering’, such as seeing his football team play.¹⁰²

But this message missed the mark. Community concern about the virus was reaching a tipping point, with Australians panic-buying toilet paper and other goods. By 2 March 2020, Australia recorded its first case of community transmission, and Australia’s policy response was propelled into the next phase of policy action.

Phase 3: Cautious incrementalism

Throughout early March 2020, the Commonwealth Government’s response shifted. It became clearer that COVID-19’s long incubation period, and asymptomatic and mildly symptomatic cases made it difficult to prevent transmission. Action grew incrementally, with additional measures to ‘slow the spread’. The Government took cautious steps during this phase, careful to have a ‘proportionate’ response to specific high-risk countries.

Bans on foreign nationals entering Australia were extended to Iran, South Korea, and Italy in the first two weeks of March 2020, as COVID-19 spread in these countries. Australian travellers from these countries were required to self-isolate for 14 days on arrival. When these bans were introduced, Iran had 978 cases (2 March), South Korea had 6,284 (5 March), and Italy had 12,462 (11 March).

By 15 March, when Australia had 300 confirmed cases, mostly from overseas arrivals (and mostly from travellers coming from the US),¹⁰³ self-isolation was made mandatory for all international arrivals,

102. Ibid.

103. National Incident Room Surveillance Team (2020a, p. 2). At 14 March, 22 per cent of cases in Australia were linked with recent travel history in the US. Italy was the second largest overseas source of cases (at 11 per cent).

although enforcement measures were weak. State health officials ramped up contact tracing and testing to reduce the risk of community transmission. By mid-March 2020, more than 100,000 tests had been conducted.

The Commonwealth Government also prepared for the inevitable pressures on Australia’s health system and impacts on its economy.

The Commonwealth made an uncapped health funding agreement with the states and territories on 6 March 2020, agreeing to meet half the increased health costs of patients with COVID-19, with an initial Commonwealth commitment of \$500 million. This was quickly followed by a \$2.4 billion health package on 11 March 2020, which provided funding to purchase more PPE and for other measures such as telehealth.¹⁰⁴

But the Commonwealth Government’s measures still appeared to underestimate the scale of the response required. On 12 March, the Commonwealth announced its first (relatively small) \$17.6 billion economic package of measures, described as ‘economic stimulus’ (i.e. the Government still did not see the size of the problem and the need to support rather than stimulate). It did not include support for people who had lost employment because of business closures.

By early March 2020, the states and territories also began to slowly announce a ramped-up public health response. Some states began to set up specific COVID-19 testing clinics, and South Australia established the first drive-through testing centre.

But by mid-March, it became clear that much more was needed to restrain the emerging exponential growth of the virus.

104. Morrison (2020d).

Phase 4: Escalated national action

The second half of March 2020 was a turbulent period of significant change. Within two weeks, Australia moved to a full shutdown. Widespread social distancing measures were announced alongside broader travel bans, testing, contact tracing, and quarantine.

During this phase, debate centred on how far Australia should go – whether it should ‘slow the spread’, or go harder and ‘stop the spread’.¹⁰⁵ The primary motivation was to protect Australia’s health system and prevent hospital ICUs being overwhelmed by COVID-19 patients.

This phase started with pressure mounting on governments to take stronger action to reduce the risk of community transmission. Debate heightened about whether the Melbourne Grand Prix should go ahead on 13-15 March.

Because critical responsibilities – such as imposition of social distancing requirements – are vested in state governments, the Commonwealth had no power over such changes, either to introduce lockdowns or to allow people and the economy to continue as normal. There was no consistency among states in their approaches. But it became clear that a national approach to coordination was needed, and on 13 March 2020 a new National Cabinet made up of the Prime Minister, Premiers, and Chief Ministers was set up. It began to meet at least weekly to coordinate Australia’s response to COVID-19.

The National Cabinet dealt the Prime Minister into discussion of state decisions, and gave the states political cover for difficult choices.

105. See Daley and Duckett (2020); Duckett (2020a). Note that some experts raised concerns that although ‘stopping the spread’ would be ideal, elimination is very difficult to achieve. It requires a high degree of confidence that every active case has been detected so that any new cases can only come from outside the geographic area. See Plank et al (2020).

Because it was set up in haste, there were no real rules for its operation. It has no decision-making power – that still rests with each of the participants – and there is no collective accountability to the public through any of the parliaments. Often the outcome of a National Cabinet meeting was a ‘decision’ in name only. Often, behind the fig-leaf of unity, each state and territory went its own way (e.g. on the timing of easing of restrictions, and of schools reopening).

Nevertheless, the public appreciated the veneer of cooperative action. The National Cabinet helped build a unified federated voice at a time when clear and consistent messaging was key (although this didn’t always work). It (partially) corralled the cats, a task made easier because their interests were aligned.

The first national social distancing announcement followed immediately on 13 March. Social gatherings were limited to fewer than 500 people. But the Commonwealth still hesitated on the precipice of change, when the Prime Minister sought to reassure Australians that the limit would only take effect after the weekend, during which he was still intending to go to the footy. Governments continued to move incrementally, limiting social gatherings to 100 people.

Australia’s case numbers began to increase exponentially, doubling every 3-to-4 days (mostly due to overseas travellers). Australians, seeing the daily news broadcasts of Italy’s overwhelmed health system, feared that could be Australia’s fate unless stronger action was taken. Many Australians, including influential commentators, thought the Government was doing too little.¹⁰⁶ Pressure mounted to introduce much tougher restrictions earlier to minimise the long-term damage to health and the economy.¹⁰⁷ Further social distancing measures were announced, limiting indoor social gatherings to 10 people, and then, by the end of the month, to two people. State and territory government

106. Doelitzsch (2020).

107. Daley (2020).

directives shut down all non-essential businesses and activities, and Australians were urged to ‘stay at home’. The Australian people increasingly accepted these measures.

It was also clear that a number of Australians returning from international travel had contracted COVID-19, particularly after travel in the US and on cruise ships, the latter mostly from the Ruby Princess, whose passengers were allowed to disembark in Sydney on 19 March even though there were active cases on board.¹⁰⁸

It had quickly become clear that some returning travellers were not adhering to the self-isolation requirement, and so finally, on 28 March, the Commonwealth Government further tightened border controls, requiring mandatory quarantine in designated facilities for all remaining arrivals.¹⁰⁹

In their efforts to control the spread of the virus, states and territories closed their interstate borders. Border restrictions started with Tasmania on 20 March, followed by the NT, WA, SA, and Queensland within a few days.

Aboriginal and Torres Strait Islander people also led responses to COVID-19.¹¹⁰ Land councils moved early to effectively close access to communities.¹¹¹ Other preparedness steps included building testing capacities in communities, preparing local action plans, and creating

108. Note also that screening at airports was initially mainly limited to passengers arriving from high-risk countries. When ramped up, there were problems with execution (such as what occurred at Sydney Airport at the end of March): J. Davies (2020).

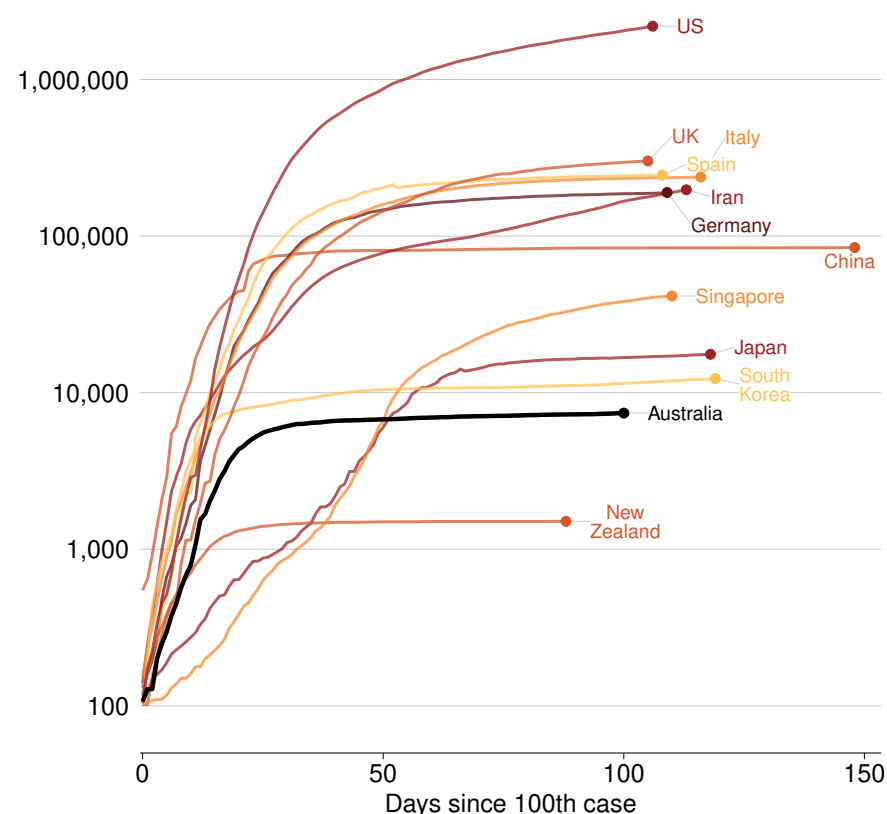
109. Houston (2020); and Cunningham (2020b).

110. Markham et al (2020, pp. 10–13).

111. Involving First Nations people in pandemic preparedness and response was a key recommendation coming out of the review of Australia’s response to H1N1, where a disproportionate number of First Nations people were infected by the disease: Department of Health and Ageing (2011) and Crooks et al (2020).

Figure 2.2: Australia’s case numbers had slowed while they continued to increase in some comparable countries

Number of confirmed cases of COVID-19, log scale



Notes: Data current as at 20 June, 2020.

Source: Data from Johns Hopkins Coronavirus Resource Center (2020). See also Daley and Cowgill (2020).

additional spaces for isolation and quarantine.¹¹² No Indigenous people have been diagnosed with COVID-19 in remote or very remote areas.¹¹³

During this period of rapid change, inconsistencies in the messages and approach between the Commonwealth Government and the states began to emerge. The Commonwealth continued to take a more risk-tolerant approach to the introduction of widespread infection control measures. The states and territories, particularly NSW and Victoria, were more risk-averse and enacted more comprehensive measures such as school closures to prevent spread of infection and to reduce the prospect that public hospitals, the responsibility of states, would be overwhelmed.

States and territories also rapidly increased their public hospital ICU capacity. Governments worked to prepare for the tripling of Australia's ICU capacity, from 2,400 beds to 7,000.¹¹⁴ The Commonwealth allocated PPE from the national stockpile, while governments ordered more supplies, including ventilators, from overseas. The Commonwealth also boosted its public health funding with another \$1.1 billion to expand telehealth, and to allocate more resources to mental health care, domestic violence support, and relief services for vulnerable Australians.¹¹⁵

The Commonwealth refined its crisis governance structures to manage the economic and social fall-out. It established a new National COVID-19 Coordination Commission, with leaders from the private and not-for-profit sectors, to advise the government on how to limit the economic and social damage caused by the crisis.¹¹⁶

Within 10 days, the Commonwealth rolled out two large economic support packages amounting to \$176 billion of spending.¹¹⁷ These included the doubling of the JobSeeker payment (previously called Newstart), and a JobKeeper wage subsidy to keep people connected to their employer.

State governments began to progressively implement their own support packages for their local economies and industries, including grants, loans, and tax deferrals. As at 2 April, these announcements amounted to almost \$15 billion nationally.¹¹⁸

By the end of March 2020, once the shock of the shutdowns had set in, the Commonwealth sought to cushion the blow by providing free childcare,¹¹⁹ and the National Cabinet announced a moratorium on rental evictions, to be implemented by the states and territories.¹²⁰

A range of health measures was also introduced. At the end of March, the National Cabinet temporarily suspended all non-urgent elective surgery in both the public and private hospital systems, to free up capacity to treat COVID-19 patients and to preserve PPE, which was in short supply. In record time, the Commonwealth struck a \$1.3

112. Crooks et al (2020).

113. National Incident Room Surveillance Team (2020b, p. 2).

114. Senate Select Committee on COVID-19 (2020a, p. 17). The Chief Medical Officer noted that this refers to being *prepared to increase* the number of ICU beds if required, rather than an intention *to increase* capacity to 7,000 beds.

115. Morrison (2020b).

116. Morrison (2020e).

117. D. Wood et al (2020b).

118. D. Wood et al (2020a).

119. There was a significant drop in enrolments as parents began to pull their children out of childcare: Klapdor (2020). Free childcare began on 6 April and was set to remain in place for about three months.

120. Morrison (2020f). Note that the moratorium has been implemented differently across jurisdictions, with the Northern Territory opting not to implement it.

billion deal to underwrite private hospitals during the elective surgery shutdown, and states negotiated to use private hospital beds, including for the transfer of public hospital patients to private hospitals.

Because most of the COVID-19 deaths were among older people, new measures were imposed on aged-care facilities. The number of visitors was restricted, as were resident movements, and staff were required to get vaccinated against the flu. The Commonwealth announced \$445 million of additional funding for residential and home-care services for older people.¹²¹

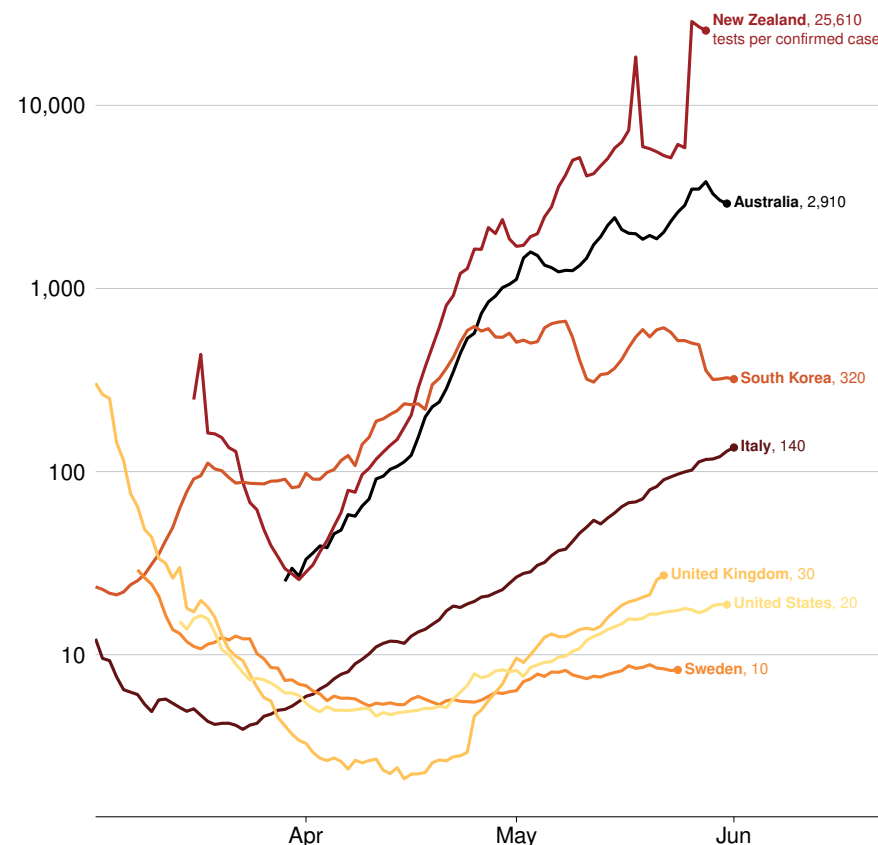
Some states enhanced their social distancing measures, including effectively closing their public schools by bringing the Easter holidays forward. They also focused public attention on the restrictions, with police issuing hefty on-the-spot fines to people breaking the social distancing rules.

As Australians settled into the ‘new normal’ of stay-at-home life, their efforts were quickly rewarded in the case count: Australia appeared to be flattening the curve. New cases were rapidly falling, with an average daily new case rate of 70 through April 2020 (see Figure 2.1). This was in stark contrast to some comparable countries, such as the US and the UK, which failed to get the virus under control(see Figure 2.2).

This coincided with expanded testing, as new testing kits came into the market. At first, testing was limited to people who were showing symptoms and had recently been overseas or had had contact with a confirmed COVID-19 case. But then testing was expanded to health workers, people in high-risk areas, and people in known clusters, and then to any person showing symptoms. The aim was to identify community transmission. Some states went further still: South Australia and Victoria launched testing ‘blitzes’ to uncover remaining cases in the community. Victoria’s testing blitz exceeded its aim of testing 100,000

121. Morrison (2020g).

Figure 2.3: Australia has one of the highest testing rates in the world
Number of tests per confirmed COVID-19 case, log scale



Notes: The number of tests shown in this chart can mean different things in different countries. Some countries report the number of people tested; some report the number of tests; for others it is unclear. See *Our World in Data* (2020a).

Source: Grattan analysis of *Our World in Data* (ibid).

people within two weeks; anyone with symptoms was eligible for testing. By the end of April 2020, more than half a million Australians had been tested for COVID-19, with an average positive testing rate at the time of 1.2 per cent.¹²²

Phase 5: Transition to a new normal

After more than a month of 'stay-at-home' life, Australia began to move to a new normal at the end of April 2020. Case numbers were dwindling to below an average of 20 new cases a day at the start of May, with some states recording successive days with no new cases. As at 1 May, 83 Australians were in hospital with COVID-19 and 28 people were in ICUs, far short of the original, pre-lockdown, gloomy predictions and nowhere near overwhelming Australia's healthcare system.¹²³

Governments finalised their preparations to ease restrictions and manage the virus into the longer-term. This involved further boosting contact tracing capabilities, and increasing testing to identify community cases.

To assist with contact tracing, on 26 April the Commonwealth Government launched its COVIDSafe app to 'automate and improve what state and territory health officials already do manually'.¹²⁴

The app aims to help overcome problems associated with manual contact tracing such as people not knowing, not remembering, or misremembering, who they've had contact with.¹²⁵ The app tracks other phones – also running the COVIDSafe app – it is close to for

15 minutes or longer. If a person is subsequently diagnosed with COVID-19, a health official provides a PIN that allows the user to upload their list of contacts to the cloud, to be accessed by state or territory contact tracers.¹²⁶ About 6 million people have downloaded the app as at 1 June,¹²⁷ well short of the Government's original target of 40 per cent of the population (about 10 million people).¹²⁸ How many actually have the app working as it should – keeping it open, with Bluetooth on¹²⁹ – is unknown, as is the number of people who have removed it.¹³⁰

But evidence is emerging that the app has never really worked well. In the only known use of the app for contact tracing since its launch, health authorities in Victoria were able to identify one additional contact not remembered by the initial case.¹³¹ And documents released by the Digital Transformation Agency show that when launched, the app only worked on locked iPhones a quarter of the time or less, contrary to government assertions about the app's functionality.¹³²

State governments started to ease restrictions regardless, armed with the confidence created by low case numbers. Queensland, the NT, and WA were the first to announce small changes. This included the lifting of restrictions on national parks, and WA joining the NT in allowing gatherings of up to 10 people.

At the same time, the Prime Minister started to shift his rhetoric from concern about the health risks to concern about the economic

122. As at 30 April 2020. Positive testing rates varied between 0.6 per cent in the NT and 1.9 per cent in Tasmania. Note that the testing rate per person also varied between the states and territories. See Department of Health (2020c).

123. Department of Health (2020d).

124. Morrison (2020g).

125. Leecaster et al (2016) found that sensors recorded twice as many contacts occurring for 20 seconds or longer than self-reported contacts.

126. Duckett and Mackey (2020c).

127. O'Brien et al (2020).

128. Although the Government has since moved away from that target: J. Taylor (2020a).

129. The iPhone version of the app may also not work as intended: J. Taylor (2020b).

130. T. Taylor and Swan (2020).

131. Ibid.

132. Bogle (2020). This increased to between a quarter and half the time by 14 May 2020.

fall-out from the crisis. The Commonwealth Government estimated the lockdown was costing Australia's economy about \$4 billion each week.¹³³

Building on the momentum to ease restrictions, on 8 May 2020 the National Cabinet agreed to a three-step plan and a national framework to bring Australia out of lockdown over the next few months.¹³⁴ Step 1 allows outdoor gatherings of up to 10 people and five visitors in the home, some businesses to open, and some recreational activities. Step 2 allows outdoor gatherings of up to 20 people and further businesses to open, including gyms and entertainment venues such as cinemas. Step 3 allows gatherings of up to 100 people and remaining workers to go back to their workplaces. International border restrictions will remain for the 'foreseeable future'.

Within the national framework, state governments are ultimately responsible for easing lockdowns. Some jurisdictions, such as WA and the NT, which have lower case numbers, are moving faster than others with higher case numbers, such as Victoria and NSW.

As at 1 June, case numbers have remained under 20 new cases a day as restrictions continue to be unwound. This is complemented by continued contact tracing efforts by state authorities, with continued high rates of testing (see Figure 2.3 for Australia's comparatively high testing rates). Australia has now done nearly 1.5 million tests.¹³⁵

To continue managing the secondary health impacts of the crisis, the Commonwealth Government announced a \$48 million mental health program on 15 May, and launched another inquiry into domestic violence on 30 May.

133. Frydenberg (2020b).

134. Morrison (2020h).

135. Department of Health (2020a). Note the rate of testing varies between states and territories.

But as restrictions unwind, attention is turning to the adequacy of the Commonwealth Government's economic response to the crisis. There is mounting criticism that the Commonwealth's income support payments are too narrowly targeted. Many people in industries hardest hit, such as workers in the arts and entertainment industry or in hospitality, including temporary migrant workers, do not qualify for the wage subsidy scheme. Public universities were also effectively excluded from the scheme. This criticism was amplified when the Commonwealth announced on 22 May that it had made a mistake. It revised the expected cost of the JobKeeper program down by \$60 billion from \$130 billion to \$70 billion – which arguably makes room to expand the eligibility of the scheme.¹³⁶

To focus efforts on the economic road out, and to build on the cooperative effort of the National Cabinet, Prime Minister Scott Morrison made the National Cabinet a permanent fixture, replacing the previous inter-jurisdictional forum, the Council of Australian Governments, or COAG.¹³⁷

2.2 Reflections

2.2.1 Four successes

Australia's response to COVID-19 to date has been among the most successful in the world. From a peak of more than 400 new cases a day, the rate has stayed below 20 since mid-April, and some states are recording successive days with no new cases.¹³⁸

Australia has avoided the worst of the pandemic (at least for now). Comparable countries, such as the UK and US, are mourning many thousands of lives lost and are still struggling to bring the pandemic under control. The reasons for Australia's success story are complex,

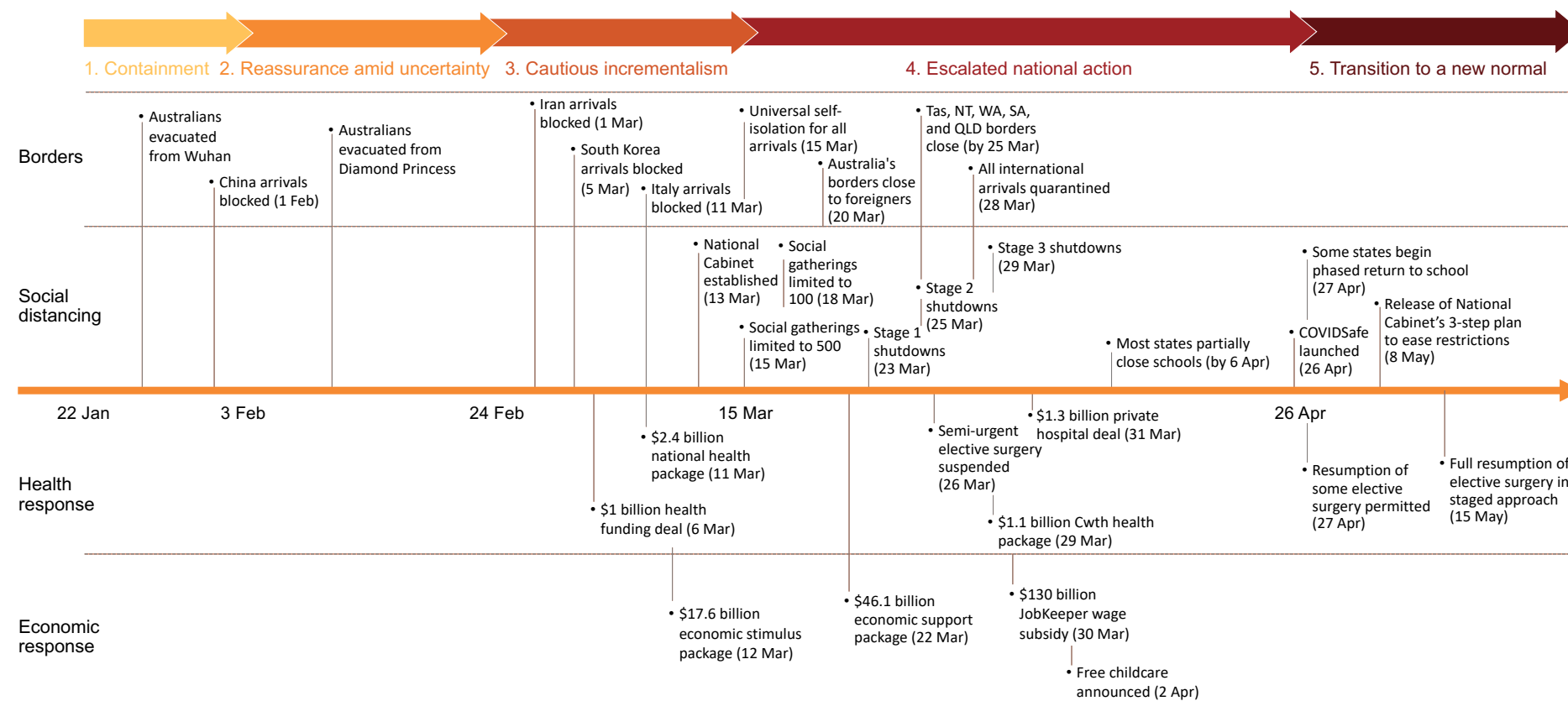
136. Hitch (2020).

137. Morrison (2020i).

138. As at 1 June 2020.

Figure 2.4: A timeline of Australia's major COVID-19 policies

Categories of response measures by each policy phase



Source: Grattan Institute's Coronavirus Announcements Tracker.

and success may yet be temporary, but four factors have been important.

Success 1: Cooperative governance informed by experts

The formation of a National Cabinet, comprising the Prime Minister and the leaders of each state and territory government, was a key part of Australia's successful policy response to COVID-19.

The states and territories have primary responsibility for public hospitals, public health, and emergency management, including the imposition of lockdowns and social distancing restrictions. The Commonwealth has primary responsibility for income and business support programs. Coordination of these responsibilities was critical.

Although the National Cabinet was created quite late – in mid-March 2020 when cases were beginning to increase exponentially – it has proven to be an effective mechanism to resolve most differences and coordinate action as much more dramatic and far-reaching measures were put in place.

Within a week of the National Cabinet being formed, Australia began to progressively implement restrictions on social gatherings. On 22 March, in advance of a National Cabinet meeting that evening, Victoria, NSW, and the ACT announced they were proceeding in the next 48 hours to implement a shutdown of all non-essential activity. This helped push all other governments into widespread business shutdowns announced by the Prime Minister that night, to take effect the following day.

The inter-jurisdictional Australian Health Protection Principal Committee (AHPPC) further enhanced national cooperation. From the start of the crisis, this forum helped underpin Australia's decisions with public health expertise. The AHPPC's recommendations informed government decisions, particularly the expansion of social distancing measures. It is now commonplace to have the Prime Minister give a

national press briefing alongside the Chief Medical Officer, who chairs the AHPPC.

The Commonwealth Government was criticised, however, for announcing it was suspending Parliament until August.¹³⁹ While the Commonwealth was making significant national decisions, including record spending commitments, the suspension meant the Government had minimal formal oversight. To at least partially overcome this deficiency, on 8 April 2020 the Senate set up a select committee to provide some checks and balances on the Government's response.

Success 2: Closure of international borders, and mandatory quarantine

Australia's 20 March decision to close its borders to all foreigners to 'align international travel restrictions to the risks' was a turning point in Australia's response.¹⁴⁰ The overwhelming number of new cases during the peak of the crisis (about 80 per cent) came from or were directly linked to someone who had been overseas.¹⁴¹ And overseas sources of infection have accounted for nearly two-thirds of Australia's total cases to date (see Figure 2.5).

This decision was a key part of Australia's 'escalated national action' phase. Within two weeks of Australia's borders being closed to foreigners, Australia's daily case numbers began to fall.

And once this measure was coupled a week later with mandatory quarantine at designated facilities for all Australian international arrivals, Australia had much more control over the spread of the virus.¹⁴²

139. Horne (2020).

140. Morrison (2020g).

141. Morrison (2020j).

142. Dickens et al (2020); and S. L. Chang et al (2020).

Success 3: Rapid adoption and acceptance of enhanced social distancing measures

Australia's rapid adoption of social distancing measures reduced the risk of community transmission.

Once Australians could see the risk of the virus overwhelming the nation's health system, highlighted by Italy's struggling health system at the brink of collapse, people quickly complied with shutdown laws.¹⁴³ In fact, Australians had already begun reducing their activity before the restrictions were imposed.¹⁴⁴

Mobility data shows a dramatic drop in Australians going to shopping centres, recreational facilities, using public transport, and commuting to work through March, April and May compared to usual (see Figure 3.4).¹⁴⁵ Australians' compliance is also demonstrated by the low number of local transmissions, despite having less-strict lockdown laws than some countries such as France and New Zealand.¹⁴⁶

Success 4: Expansion of telehealth

One of the Commonwealth Government's early healthcare interventions was to radically expand Australians' access to telehealth. Telehealth enables patients to consult health professionals via videoconference or telephone, rather than face-to-face. This means that healthcare workers and patients can remain home rather than put themselves at risk by having to visit a healthcare clinic or a doctor's waiting room.

143. Armocida et al (2020).

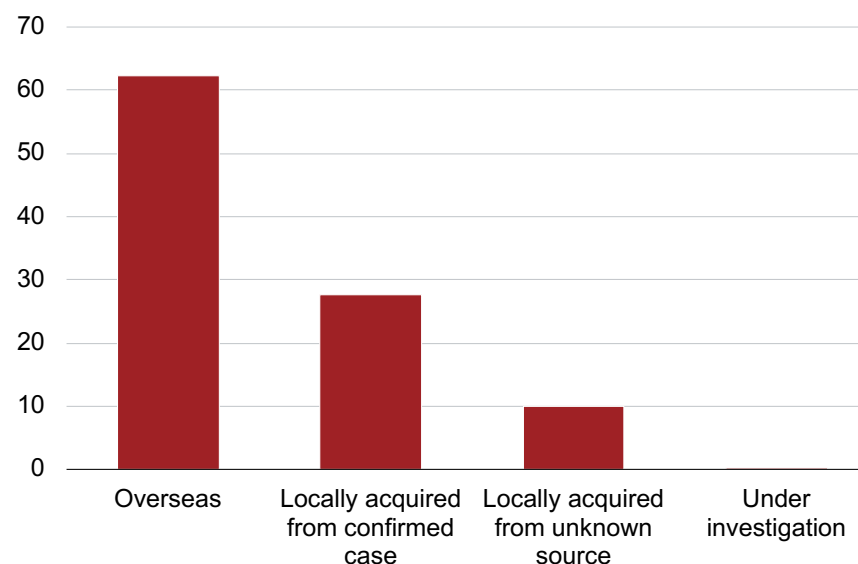
144. Terrill (2020).

145. Ha et al (2020).

146. Early indications, from the start of April 2020, showed Australians were about 90 per cent compliant with social distancing measures (Hanrahan and Liddy (2020)), as real case numbers showed a similar pattern to modelling of 90 per cent compliance by S. L. Chang et al (2020).

Figure 2.5: Nearly two-thirds of Australia's COVID-19 cases have come from overseas

Per cent of total cases



Notes: This is based on Australia's total number of cases from 22 January to 1 June. Overseas means the person was infected in another country or at sea. Locally acquired from unknown source means that the person was infected in Australia, but the source of infection is not yet known. Under investigation, accounting for 0.2 per cent of total cases as at 1 June, means that the source of the infection has not yet been determined but is being investigated by public health officials.

Source: Department of Health (2020e).

The Commonwealth commenced a drip-feed of these measures in its \$2.4 billion health package on 11 March 2020, and subsequently phased-in broad-scale telehealth services for all Australians. Within six weeks, more than 250 new ‘temporary’ items had been added to the Medicare Benefits Schedule, which extends to seeking advice from allied health workers and specialists.¹⁴⁷ These changes were complemented with changes to medication services, enabling electronic delivery of prescriptions to the pharmacy, with options for patients to have medications delivered to their homes.

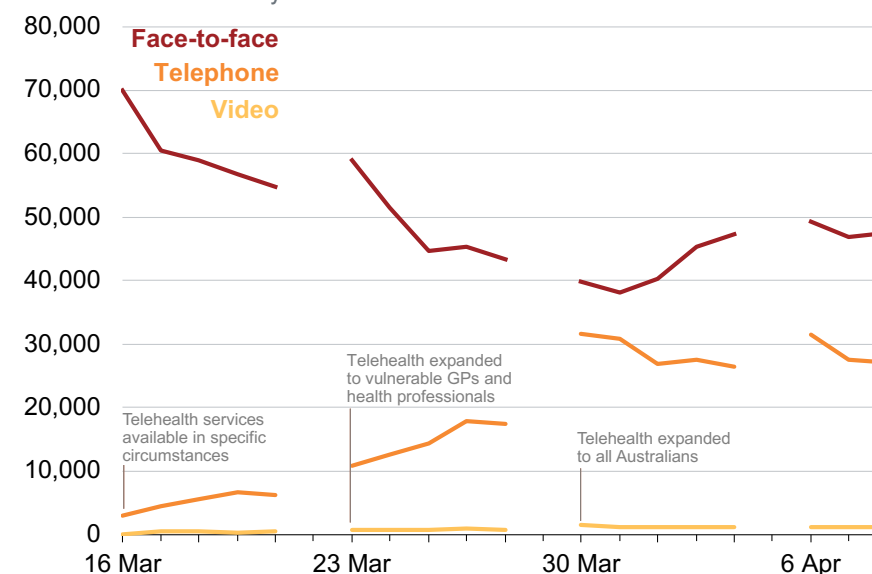
Australians have enthusiastically taken up telehealth services, particularly telephone consultations (see Figure 2.6), with more than 4.3 million medical and health services delivered to three million patients in the first month.¹⁴⁸ A Royal Australian College of General Practitioners (RACGP) survey of more than 1,000 GPs found that 99 per cent of GP practices were now offering telehealth services, with 97 per cent also continuing to offer face-to-face consultations.¹⁴⁹ See Section 4.1 for our recommendations on the future of telehealth.

2.2.2 Four failures

Unfortunately, Australia has also had failings. The most obvious is the handling of the Ruby Princess cruise ship, but Australia might have been in a better position today if it had acted against the virus more quickly and if our leaders had been clearer about their overall longer-term strategy for managing the virus.

Australia eventually ‘went hard’, but it was too slow to get started. The Commonwealth Government spent too long in the early days flailing in uncertainty about the scale of the crisis. As a result of this hesitancy, the Government was too slow to shut international borders and to

Figure 2.6: Australians have taken to telephone GP consultations during the COVID-19 outbreak
MBS items on weekdays



Notes: Data from five Primary Health Networks: Central & Eastern Sydney, South Western Sydney, Gippsland, Eastern Melbourne, and South Eastern Melbourne. Face-to-face MBS items 3, 23, 36, 44; Telephone MBS items 91795, 91809, 91810, 91811; and Telehealth ‘Video’ MBS items 91790, 91800, 91802.

Source: Outcome Health (2020b).

147. Department of Health (2020a).

148. Hunt (2020c).

149. RACGP (2020).

prepare the healthcare system for the possibility of a huge influx of COVID-19 patients.

Failure 1: The Ruby Princess

About 2,700 Ruby Princess passengers were allowed to disembark freely in Sydney on 19 March 2020, despite some showing COVID-19 symptoms. The cruise ship has become Australia's largest single source of infection. About 700 cases (10 per cent of Australia's cases) and 22 deaths (about 20 per cent of Australia's deaths) are linked to the ship.¹⁵⁰

On 15 April 2020, the NSW Government launched a Special Commission of Inquiry¹⁵¹ to investigate what went wrong, and a Senate Select Committee began to inquire into the case.¹⁵² NSW Police will also spend the next six months investigating what was known about the potential coronavirus cases before the Ruby Princess was allowed to dock.

Failure 2: Too slow to fully close the borders

While the closure of international borders was a turning point, Australia waited too long to do so. Australia was comparatively quick to ban foreign nationals coming from China, but it was slow to introduce any further travel restrictions.

As the virus spread beyond China, and Australia continued to have thousands of international arrivals each day, it took more than six weeks after Australia's first confirmed case for the Commonwealth

Government to introduce universal travel restrictions.¹⁵³ Before this, restrictions were targeted at specific countries, such as Iran, South Korea and, belatedly, Italy – despite other countries such as the US posing similar or even greater risks. The Commonwealth Government was also too slow to establish compulsory quarantine at hotels – there was too much reliance at the outset on self-isolation.

Failure 3: Too slow to prepare the health system

Australia was too slow to ready its health system for the prospect of the virus spreading rapidly. When cases began to rise exponentially, Australia was ill-prepared for a pandemic-scale response.

Australia's testing regime faced some early challenges. At first, some people with symptoms went to community GP clinics or hospitals, without calling ahead, putting others at risk.¹⁵⁴ On 11 March 2020 the Commonwealth Government announced 100 testing clinics would be established, but this was only completed two months later, once the peak of the crisis had passed.¹⁵⁵

As cases began to increase in mid-March, Australia very quickly hit supply shortages for testing.¹⁵⁶ The testing regime remained narrow for too long before new testing kits could be acquired. This meant that many people who had symptoms could not be tested, potentially

153. The rate of overseas acquired cases began to increase in late February and early March – particularly from Europe and the US, as COVID-19 spread to more countries.

154. Woodley (2020a). At this time, there was inconsistent messaging on how to go about getting tested, with different jurisdictions giving different advice: Keane (2020).

155. Hunt (2020d).

156. Murphy (2020). Initially broken supply chains and the novel nature of SARS-CoV-2 meant reagents and kits were in short supply and so testing was limited to people who were symptomatic and were at potential risk of being infected: Knaus and Doherty (2020).

150. Cockburn (2020); and Elsworthy (2020).

151. NSW Government (2020).

152. Senate Select Committee on COVID-19 (2020a).

increasing the chances of community transmission. Broader community testing, led by state governments, did not begin until April.

As it became clearer that access to ICU beds might be a critical factor, expansions of capacity were announced – almost tripling available ICU beds. But in some cases these announcements were not made until after the peak had passed, so the additional capacity has not been used.

Australia also struggled to get adequate supplies of PPE quickly enough to meet demand. Australia's initial national stockpile of 12 million P2/N95 masks and 9 million surgical masks was not sufficient.¹⁵⁷ Supplies of gowns, visors, and goggles had also not been set aside in Australia's national stockpile in the event of a crisis.¹⁵⁸ GPs complained of inadequate supplies hampering their work.¹⁵⁹ There were early reports of poor communication with GPs about PPE requirements and supply.¹⁶⁰ Eventually, on 26 March 2020, elective surgery was severely curtailed so that PPE could be diverted to frontline health workers dealing with the pandemic.

As shortages loomed, Australian health departments joined global bidding competitions for fast-track supplies from overseas manufacturers. Some state governments turned to local manufacturers to boost supplies.

157. Senate Select Committee on COVID-19 (2020a, p. 5). At the early stages of the pandemic, Australia's PPE supply would have run out if a bigger outbreak had occurred. The Commonwealth Government acquired hundreds of millions of masks by April to cover the shortfall.

158. McCauley (2020a).

159. See for example: Knaus (2020) and Ryan and Florance (2020). Preliminary data released in April from a national survey of 350 doctors, nurses, and paramedics found that half of the participants reported a lack of access to PPE needed to do their jobs safely: Edith Cowan University (2020).

160. For example, it was unclear how to obtain masks from the national stockpile: Woodley (2020b). This unclear communication also extended to requirements for testing: Woodley (2020c).

Failure 4: Shifting strategies and mixed messages

The lack of a clear overarching strategy to respond to the crisis has resulted in a reactive policy approach. This has led to mixed and confusing messages.

At first there was confusion about the shutdown measures: which businesses or events should close (for example, the Grand Prix). There have been inconsistencies between the Commonwealth's position and the states'. For example, most states closed or partially closed their public schools around Easter, and began re-opening them when cases went down more than a month later. Despite concerns raised by some state governments, the Commonwealth asserted children were not at risk, with the Prime Minister repeatedly encouraging parents to send their children to school. Childcare centres also remained open.

The mixed messages have been particularly pronounced on Australia's strategy to manage the virus. Initially the Commonwealth Government talked about 'slowing the spread', while some states argued for a 'stop the spread' strategy. This tension increased confusion about how far Australia's lockdown restrictions should go. Debate raged between people who argued that 'herd immunity' was Australia's only option, and people who pushed for 'elimination' of COVID-19 in Australia.¹⁶¹

When clarity was sought from the Commonwealth, the messaging remained unclear. A 16 April 2020 statement from the Prime Minister, designed to clarify the Commonwealth's position on its longer-term strategy, confused two different strategies as one, by saying Australia was continuing to 'progress a successful suppression/elimination strategy for the virus'.¹⁶² As the debate continued, the case count forged its own story, showing that elimination may be possible as more

161. Duckett (2020b); and Daley and Duckett (2020).

162. Morrison (2020k). Note that we interpret 'suppression' to mean controlling the incidence of new cases so the health system can cope. 'Elimination' is where cases are at effectively zero.

and more states began to record multiple days and weeks with no new cases.

2.2.3 Now for the new normal

As restrictions are unwound, a new normal will set in. The risk of COVID-19 cases jumping again means Australians' way of life will have to fundamentally change. Significant risks remain, particularly for states that ease restrictions too fast (Section 3.9.2). Continual monitoring will be required to prevent further outbreaks or a second wave (see more in Chapter 3).

As Australia re-sets to a new normal, the successes and failures to date should guide policy makers in the recovery phase and into the longer term. In particular, we need to heed the lessons from this pandemic to build a more effective, efficient, and equitable health system (Chapter 4).

3 Coming out of lockdown

The ‘new normal’ in Australia will include continued restrictions on international travel, public gatherings, public transport, schools, workplaces, and community activities to prevent the transmission of COVID-19.

Australia is progressively easing social distancing restrictions and coming out of lockdown. Decisions on when – and in which order – restrictions are eased should be informed by evidence.

Swift and accurate contact tracing will be crucial as students return to the classroom and workers return to the office. But contact tracing alone is not sufficient – it should be combined with structural measures and ongoing social distancing to increase the likelihood of controlling outbreaks.

Workplaces are particularly high risk and should be re-opened slowly, with as many people as possible continuing to work from home to minimise the number of people interacting. Schools should have social distancing policies in place, and should close if a case is detected.

While there are active cases of COVID-19 in Australia, there is always the possibility of a second wave. The risk of a second wave is higher if policies and behaviour return to normal too soon. State governments must be prepared to act decisively to control outbreaks, through local lockdowns if need be.

However successful Australia might be at containing COVID-19, mandatory quarantining of international arrivals will still be needed for quite some time.

3.1 Modelling the impact of policy interventions on the spread of COVID-19

Modelling plays an important role in our understanding of how disease spreads. It helps us understand the impact of past decisions, and allows us to peer into possible futures to plan ahead.¹⁶³

While the UK was pursuing a herd immunity strategy in early March 2020, the Imperial College COVID-19 Response Team released simulation-based modelling showing the plan would overwhelm hospitals and cost more than 500,000 lives.¹⁶⁴ Their model’s results made clear a disastrous likely scenario, and policy makers abandoned this folly.

In Australia, the Doherty Institute of Infection and Immunity and the Melbourne School of Population and Global Health developed models for the Commonwealth Government.¹⁶⁵ As the virus began to take off in Australia, these researchers provided a mathematical model that demonstrated the potential spread of COVID-19 and its impact on our healthcare system.¹⁶⁶ This helped guide the Government’s decision making outlined in Chapter 2.

Mathematical models have since shown that delaying the lockdowns by a week could have resulted in a five-fold increase in COVID-19 infections in Australia.¹⁶⁷ Others have been developed to forecast infection rates around the world.¹⁶⁸

163. Peng and Currie (2020).

164. Ferguson et al (2020).

165. Shearer et al (2020).

166. Moss et al (2020).

167. Marschner (2020).

168. Phillips et al (2020).

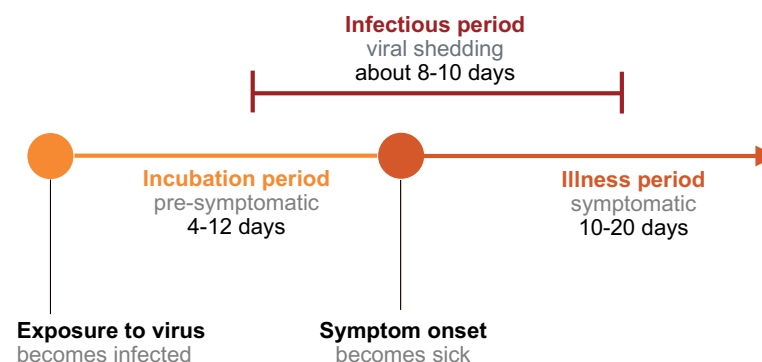
Researchers at the University of Sydney developed a microsimulation model which showed the levels of social distancing Australia would need to curtail the rapid spread of the virus.¹⁶⁹ These types of models have been used around the world to explore the spread of COVID-19 and assess policy and behavioural interventions.¹⁷⁰

Grattan Institute has developed an agent-based microsimulation model to illustrate some of the risks associated with coming out of lockdown. Our model estimates the effect of government decisions on schools, work and activities in the community. This model is summarised below, and described in more detail in Appendix A.¹⁷¹

The starting point for our model is the Australian population, distributed in ‘statistical areas’, about the size of a postcode, around the country. People go to work or school. They go to the shops, and to cafes and restaurants. At night, they go home; some to their families or housemates, others alone.

At each of these places, they interact with each other. Each interaction carries risk of transmitting infections or being infected. If a person picks up enough of the SARS-CoV-2 virus,¹⁷² their viral load – how much of the virus they have in their body – will build up before they start to show symptoms.¹⁷³ This time, between becoming infected with the virus and developing symptoms, is the incubation period. A longer incubation

Figure 3.1: The stages of a COVID-19 infection



Source: Adapted from Housen et al (2020).

period means a longer time between a person *becoming* infected and *realising* they are infected.¹⁷⁴

As this viral load builds up, people start to ‘shed’ the virus by expelling small particles through coughing, sneezing, and speaking.¹⁷⁵ These viral particles can be passed from person to person directly, called ‘droplet transmission’, or can attach themselves to a surface to be picked up later, called ‘contact transmission’.¹⁷⁶ A person can be

169. S. L. Chang et al (2020).

170. N. G. Davies et al (2020); Kerr et al (2020); and Thompson et al (2020).

171. The model is written in C++ and R and can be freely accessed at Parsonage and Mackey (2020).

172. The average number of these particles needed to start an infection in another person is called the infectious dose. The higher the infectious dose, the less likely a disease is to spread. The infectious dose for COVID-19 is not yet known, but – given its rapid spread – it is likely to be low: Geddes (2020).

173. Ball (2020).

174. This is a key factor in determining quarantine lengths for people who may have been exposed to the virus, such as those identified in contact tracing, or people coming from overseas.

175. World Health Organisation (2020h).

176. World Health Organisation (2020c). The virus can remain viable on most surfaces for hours: Bar-On et al (2020); and on some surfaces such as stainless steel and plastic for longer than three days: Doremalen et al (2020). Aerosol transmission occurs when small droplets evaporate before they fall to the ground, leaving the dried-out virus to drift freely through the air: Couch et al (1966, p. 517). Whether COVID-19 can spread through aerosol transmission is an area of developing research: Morawska and Cao (2020) and Fineberg et al (2020, pp. 19, 35–37).

infectious during the last few days of their incubation period, before they show symptoms.¹⁷⁷ The incubation period lasts for six days on average, and most people who develop COVID-19 symptoms do so within 12 days.¹⁷⁸ However, some people have particularly long incubation periods – of 20 or 30 days – posing problems for quarantine measures.¹⁷⁹ This poses a particular problem: people without symptoms – and so who don't see a reason to self-isolate – spread the virus. This underscores the importance of contact tracing (Section 3.2).

Individuals are also infectious for different durations. Information about the virus to date suggests the average duration is about 8-to-10 days.¹⁸⁰ But, as with the incubation period, some people are infectious for much longer.¹⁸¹

While a person is infectious and has contact with others, they can spread the virus. For a susceptible person, the likelihood they will become infected when exposed to COVID-19 in a given situation is called the 'secondary attack rate'.¹⁸² The secondary attack rate varies by situation. In our model of COVID-19 spread, distinct secondary attack rates are given for households, schools, workplaces, shops, cafes and restaurants, and major events. These rates are shown in Table A.2 on page 85, and briefly described below.

This source of transmission has consequences for precautions and restrictions: World Health Organisation (2020c) and Yong (2020).

177. He et al (2020); Arons et al (2020); Nishiura et al (2020); Tindale et al (2020); Tong et al (2020); and Lauer et al (2020).

178. McAloon et al (2020), Backer et al (2020), Lauer et al (2020), Lu et al (2020), Qian et al (2020), Bi et al (2020), Tian et al (2020), Kong et al (2020) and Kong et al (2020). The COVID-19 incubation period literature is discussed in detail in Appendix A.8.2. See also Figure A.3.

179. C. Qiu et al (2020).

180. Housen et al (2020); and To et al (2020).

181. To et al (2020). See Table A.2 in Appendix A for the duration of infectivity used in our modelling.

182. Centers for Disease Control and Prevention (2020a).

In the home or in workplaces, where long times are spent in shared, indoor spaces, the risk of infection is high.¹⁸³ Sharing a meal – at home or in a restaurant – is particularly risky.¹⁸⁴

Schools also involve long times spent in shared spaces, and in past outbreaks of disease they have been a source of spread.¹⁸⁵ But children seem to contract and spread COVID-19 differently to adults, making schools lower risk than workplaces.¹⁸⁶

The shorter an interaction, the fewer opportunities the virus has to pass from one person to another. This means that the risk of infection is lower in places where people spend less time together, and so the probability of infection in places like shops is lower than places like restaurants.¹⁸⁷ But, as discussed in Section 3.3, low-probability interactions among millions of people every day can still lead to outbreaks. Similarly, as shown in Section 3.6, major events can be the source of COVID-19 outbreaks and pose a problem for contact tracers.

As with SARS and MERS before it,¹⁸⁸ the spread of COVID-19 is dominated by a minority: most people will pass the virus on to nobody else, others will pass it on to many.¹⁸⁹ These 'superspreaders' and 'superspreader events' have been documented from the beginning of the COVID-19 pandemic. Figure 3.2 on the following page shows superspreader events in China at the start of the year: during a dinner

183. The likelihood of infection in the home is about 10-to-20 per cent: Bi et al (2020) and Jing et al (2020). But this varies drastically depending on behaviour. See Appendix A.8.3.

184. Liu et al (2020a, table 1).

185. Ferguson et al (2005, p. 212); Cauchemez et al (2008); Kelso et al (2009); Hens et al (2009); Halloran et al (2008); Rashid et al (2015); and Fong et al (2020).

186. See Appendix A.10 for a discussion about COVID-19 and children.

187. See Appendix A.

188. Lloyd-Smith et al (2005); and Kucharski and Althaus (2015).

189. While research is evolving in this area, early analysis suggests that about 10 per cent of people are responsible for about 80 per cent of COVID-19 spread: Endo et al (2020).

in late January, one person with COVID-19 infected all other eight people; in another, one person infected 10 others. At a wedding in Jordan, an undiagnosed person spread COVID-19 to 76 others.¹⁹⁰

The goal of COVID-19 policies is to decrease the exposure of susceptible people to infected individuals,¹⁹¹ and policy makers can exploit the fact that the virus is mostly passed on by highly infectious people at superspreading events.¹⁹² Shutting down high-risk events – removing the opportunity to have superspreader events – can be highly effective. These policy decisions and their implications are discussed in the following sections.

3.2 Testing, contact tracing, and isolation are preconditions for re-opening

Robust contact tracing systems will be vital in the new normal. Contact tracing seeks to rapidly identify and assess people who may have been exposed to a disease. By isolating people who may have been infected, chains of transmission can be broken, and outbreaks controlled.¹⁹³

To be effective in preventing the spread of COVID-19, a high proportion of contacts need to be traced, and a high proportion of those identified contacts need to properly isolate.¹⁹⁴ This requires a dedicated contact tracing workforce, strong community engagement, and a system to collate and analyse data.¹⁹⁵ All Australian states and territories have expanded their contact tracing capabilities to achieve this goal.¹⁹⁶

190. Yusef et al (2020).

191. Bourouiba (2020).

192. Kupferschmidt (2020).

193. World Health Organisation (2020i).

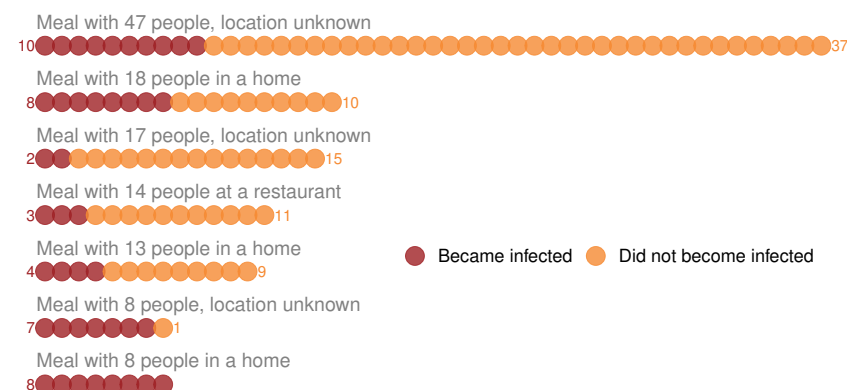
194. Kucharski et al (2020); He et al (2020); Hellewell et al (2020); and Fong et al (2020).

195. World Health Organisation (2020i).

196. The task of contact tracing was meant to be supported by the Commonwealth Government's 'COVIDSafe' app, but its use and usability has been limited. See Section 2.1.1.

Figure 3.2: Super-spreading events

Spread of COVID-19 from meal-based clusters with secondary transmission in China



Source: Adapted from Liu et al (2020a, table 1).

Contact tracing and isolation can be effective in controlling outbreaks if done well, and in conjunction with other measures. A key factor is identifying infected people and their contacts early. If a contact of a confirmed case builds up a viral load and has time to spread the virus before they are notified by contact tracers to begin isolation – or if they are not identified as a contact at all – outbreaks can spread. The longer the period between infection and isolation, the more difficult it is to get an outbreak under control.¹⁹⁷

SARS-CoV-2 mutates subtly as it spreads. Identifying and comparing different strands of the virus using whole genome sequencing provides researchers with information about possible lines of transmission,

197. Hellewell et al (2020) used a stochastic transmission model to explore the effectiveness of contact tracing and isolation during COVID-19 outbreaks under different R_0 scenarios. They found that in most scenarios, contact tracing and case isolation were enough to control an outbreak within three months.

enabling them to quickly intervene to contain outbreaks.¹⁹⁸ This method has been used successfully in Victoria, which has sequenced about three-quarters of the state’s cases.¹⁹⁹ It has also enabled identification of previously unknown clusters, and disentanglement of multiple clusters initially thought to be one.²⁰⁰

Robust contact tracing systems are essential if restrictions are lifted while the virus is still circulating in the community. If minor outbreaks occur, and can be managed through contact tracing, then governments can have more confidence about lifting restrictions. The big risk is if an outbreak occurs which overwhelms contact tracing capacity and ignites exponential spread of the virus through the community.

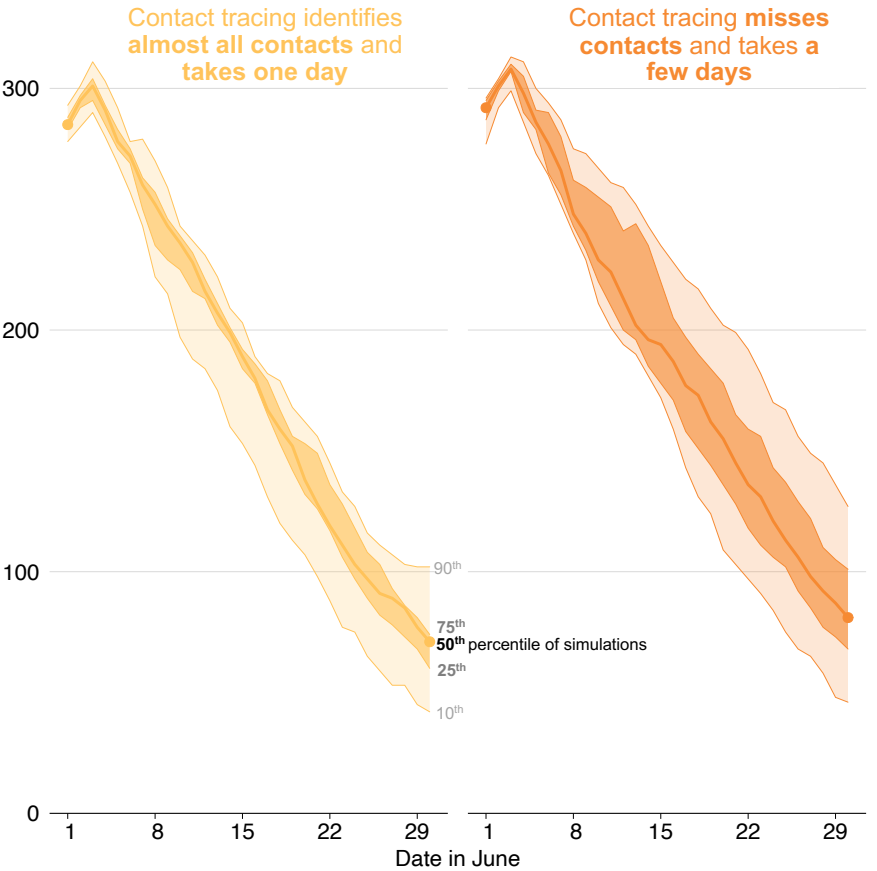
The potential spread of COVID-19 in Australia with different levels of contact tracing efficiency is explored in Figure 3.3. In both panels, shops and workplaces are open but have limits on the number of people allowed inside at the same time, and everyone is adhering to social distancing measures (these assumptions are changed in the following sections).²⁰¹

The left panel shows how cases might progress if contact tracing is nearly perfect, and authorities are able to identify almost all household and school contacts in just one day. The right panel shows the plausible outcomes if contact tracing is less efficient: if only half of contacts are identified, and the process takes three days instead of one. With poorer contact tracing efforts, the chances of undetected outbreaks rise.

While contact tracing can reduce the risk of COVID-19 cases turning into outbreaks, they cannot prevent the spread of COVID-19 alone.²⁰²

198. Caly et al (2020).
199. Seemann et al (2020).
200. Caly et al (2020).
201. See background model assumptions in Table A.2 and Table A.3.
202. Kucharski et al (2020); and He et al (2020).

Figure 3.3: Efficient contact tracing reduces the risk of outbreaks
Results from simulation of active local COVID-19 cases



Notes: Grattan’s COVID-19 microsimulation model. Starting point is imputed active local cases at June 1 (see Appendix A.11.1). This chart mostly reflects case numbers in Victoria and NSW as active cases were low or zero elsewhere (Appendix B has state results). Simulations use the settings provided in Table A.2 and Table A.3 with the following adjustments:

	Left panel	Right panel
Contact tracing, days before test	0	2
Contact tracing, days until results	1	3
Contact tracing, success	90%	50%

They must be combined with social distancing measures to increase the likelihood of controlling outbreaks.

3.3 Social distancing must be maintained in the community

Figure 3.4 shows that Australia is slowly reopening. As we do, our adherence to social distancing measures becomes crucial.

Social distancing measures are designed to separate infected and uninfected people, preventing the transmission of the virus from one person to another.²⁰³ It takes many forms. In general, keeping people at least 1.5 metres apart reduces the prospect of droplets containing the virus being picked up by an uninfected person.²⁰⁴ Masks have been the source of some confusion and controversy.²⁰⁵ Some jurisdictions have made mask wearing compulsory. Others – including the WHO until they updated their advice in June – advise that masks are not necessary for uninfected people.²⁰⁶

But while a mask does not do much to prevent its wearer becoming infected, it can significantly reduce the chance of its wearer infecting somebody else. There is evidence that wearing masks can help reduce the amount of the virus that is spread from an infected person, and the amount that is picked up.²⁰⁷ Australia's Chief Medical Officer

203. Fineberg et al (2020, p. 7).

204. Cowling et al (2020) and Chu et al (2020). See also Appendix A.

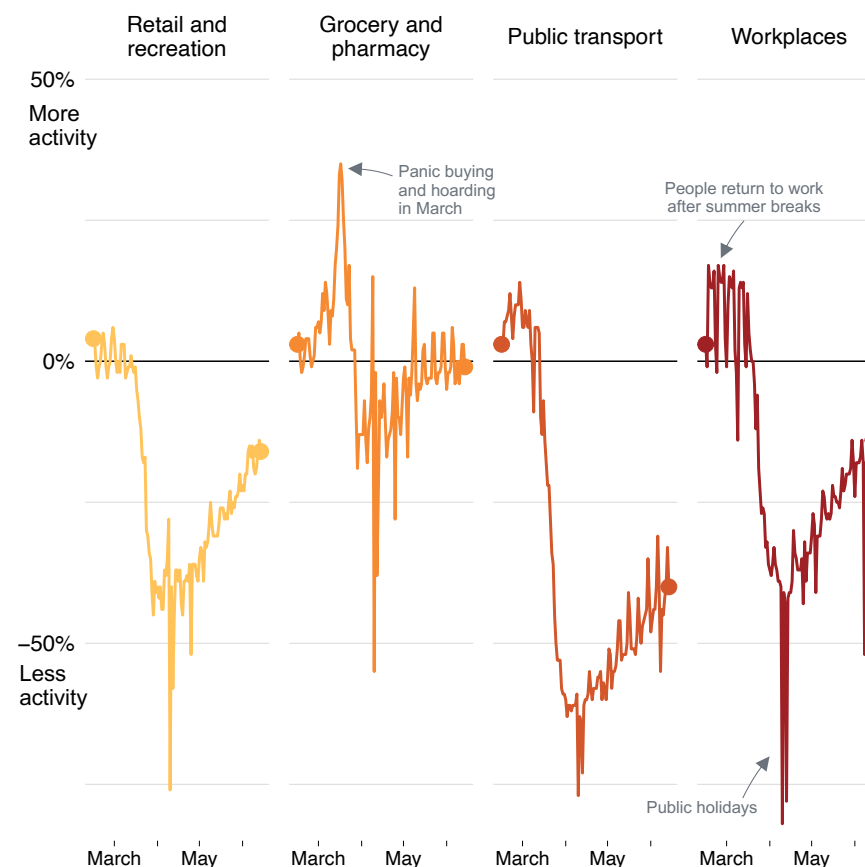
205. See Feng et al (2020, panel 1) for a summary and discussion of this mixed messaging around the world.

206. See Federal Ministry of Health (Germany) (2020), Ministry of Health Labour and Welfare (Japan) (2020), National Health Service (UK) (2020), Ministry of Health (Singapore) (2020), Centres for Disease Control and Prevention (2020), The Department of Health (Hong Kong) (2020), State Council (China) (2020), World Health Organisation (2020j) and World Health Organisation (2020k).

207. Prather et al (2020), Long et al (2020), Bartoszko et al (2020) and Chu et al (2020). However, wearing masks does not remove the spread of the virus entirely: World Health Organisation (2020l). Wide-scale adoption of mask wearing is most effective in reducing outbreaks: Eikenberry et al (2020) and Howard et al (2020).

Figure 3.4: Australia is slowly reopening

Activity in Australia from Google location data, February to June 2020



Notes: Relative to mobility in January 2020.

Source: Google (2020).

has recently supported the wearing of masks by the general public in Australia.²⁰⁸ And the public tends to agree. About 60 per cent of respondents to a Melbourne Institute survey said they were in favour of wearing masks on public transport and in cinemas.²⁰⁹

The more people wear masks, the lower the risk of outbreaks. Where there are active cases, the government should encourage people to wear masks in settings where an infected person might infect many others.

Reducing non-essential contact also takes away opportunities for the virus to spread. Limiting the amount of travel around the city and the number of non-essential visits to friends and family breaks transmission cycles, leading to fewer new cases in the following weeks.²¹⁰

Broad information campaigns about handwashing are important, but not sufficient, to change habits. Making handwash or sanitiser readily available and prominent increases use, as does signage.²¹¹ Providing the public with clear, practical advice about how they should start to re-enter the community is essential.²¹²

Wearing of masks does not decrease adherence to other social distancing measures: Kovacs et al (2020). When there is a shortage of masks, they should be reserved for people in high-risk settings, such as health workers: World Health Organisation (2020m); World Health Organisation (2020j).

208. But they will not be made compulsory in public spaces: McCauley (2020b).

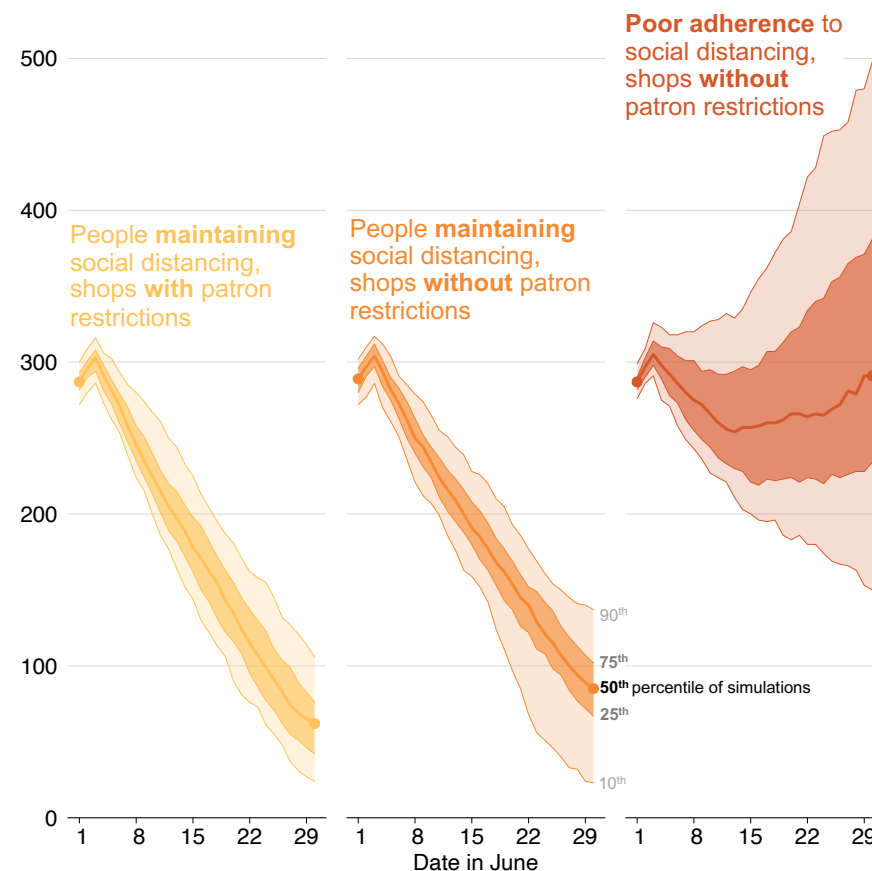
209. Melbourne Institute of Applied Economic and Social Research (2020, p. 2). Half the respondents were in favour of wearing a mask in shopping centres and in their workplace. Fewer – about 30 per cent – were in favour of wearing a mask in outdoor areas like parks and beaches.

210. In the US, Sharkey and G. Wood (2020) find that a 1 per cent increase in distance travelled in the population leads to an 8.1 per cent increase in new cases per capita in the following week. A 1 per cent increase in non-essential visits leads to a 6.9 percent increase in new cases per capita in the following week. These findings were stronger in densely populated areas.

211. Lunn et al (2020).

212. Marcus (2020).

Figure 3.5: Poor social distancing in open shops presents a severe risk
Results from simulation of active local COVID-19 cases



Notes: Grattan's COVID-19 microsimulation model. Starting point is imputed active local cases at June 1 (see Appendix A.11.1). This chart mostly reflects case numbers in Victoria and NSW as active cases were low or zero elsewhere (Appendix B has state results). Simulations use the settings provided in Table A.2 and Table A.3 with the following adjustments:

	Left panel	Middle panel	Right panel
Patron limit in shops	5	30	30
Secondary attack rate in shops	0.25%	0.25%	1%

Where the virus has been shed by an infected person, wearing masks and protective equipment, and washing hands, reduces the likelihood that enough of it will be picked up by a susceptible person.²¹³ Combining these protective measures increases the likelihood of protection.²¹⁴

People tend to touch their face 10 to 20 times an hour, and this behaviour is difficult to change.²¹⁵ A public health strategy that depends on people strictly abstaining from touching their face will probably fail.

Figure 3.5 on the previous page shows three scenarios that demonstrate the risks of lapsing into pre-COVID-19 behaviour. The first panel shows Australia at the peak of its lockdown: shops have restrictions on the number of people allowed inside at any one time, and people stay at home if they feel sick and kept their distance from others when they were out. Here, the number of cases is likely to continue its decline towards, but not reaching, zero active local cases by the end of the month.

The second panel models a scenario where the number of people allowed inside shops at any one time remains restricted, but people let down their guard and return towards normal behaviour: hugging and shaking hands, and forgetting to wash them. Under this scenario, the number of active cases in the community starts to rise.

The third panel models a scenario that maintains this poor adherence to social distancing and hand hygiene but also increases the patron limits in shops. Under this scenario, with more opportunities to spread, the virus does so quickly.

The nature of the SARS-CoV-2 virus hasn't changed; our behaviour has. This behaviour is what prevents outbreaks. If Australians go

back to pre-COVID behaviour, the virus can spread quickly, as it has elsewhere.

3.4 Reopening workplaces

A virus can move through a city via its workplaces. When people go to work, they travel to areas they otherwise wouldn't visit, and spend considerable time with people they otherwise wouldn't interact with. Closing workplaces reduced the spread of infection in previous pandemics.²¹⁶

To limit the spread of COVID-19 at work, precautions should be taken to reduce the number of people interacting at the workplace, and to minimise the opportunity for virus transmission. A staggered return to work, with only a quarter of the workplace returning at first, has been shown to be effective in Wuhan.²¹⁷

Similarly, having fewer people in an office space reduces contact.²¹⁸ This can be achieved by increasing the proportion of people who work from home on any given day by rotation, or limiting office time to essential activities.

Avoiding handshakes, minimising time spent in shared spaces, and thorough cleaning can reduce the risk of infection at a workplace.²¹⁹

The Commonwealth Department of Health suggests people at work:²²⁰

- don't shake hands;
- avoid non-essential meetings;

216. See Ferguson et al (2005).

217. Prem et al (2020). See also Cirrincione et al (2020, section 3.1).

218. Cirrincione et al (2020); and V. J. Lee et al (2020).

219. Some of these workplace containment measures are outlined in Cirrincione et al (2020, sections 3.1 and 3.2.).

220. Department of Health (2020f).

213. Jefferson et al (2009).

214. Ibid.

215. Although there is substantial variation: Kwok et al (2015).

- put off large meetings to a later date;
- if possible, hold essential meetings outside in the open air;
- eat lunch at their desk or outside rather than in the lunch room;
- avoid non-essential travel.

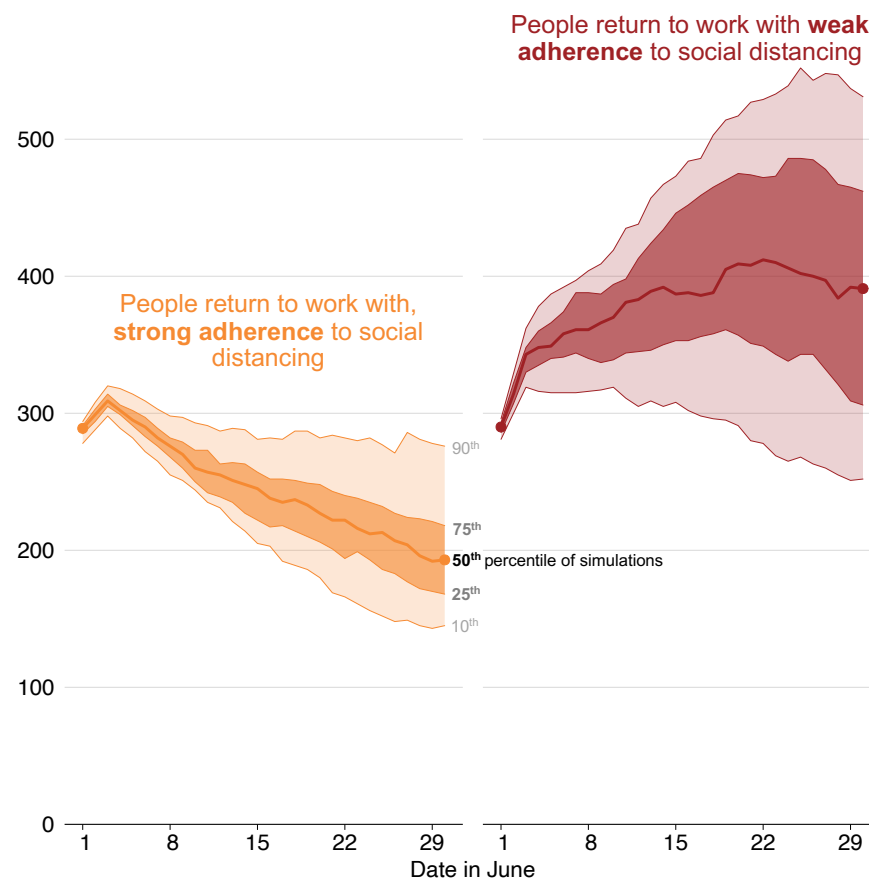
The Department suggests employers:

- promote good hand, sneeze, and cough hygiene;
- provide alcohol-based hand rub for all staff;
- regularly clean and disinfect surfaces that many people touch;
- open windows or adjust air conditioning for more ventilation;
- limit food handling and sharing of food in the workplace;
- promote strict hygiene whenever food is being prepared.

Figure 3.6 shows the effect of careful workplace reopening compared to a return to a less restrained scenario.²²¹ As with shops, lots of people sharing a common space at work with minimal precautions against infection significantly increases the risk of outbreaks that can lead to a second wave of mass infection. The risk of outbreaks is even higher once increased use of public transport returns, which is not incorporated into our modelling.²²²

Figure 3.6: Reopening workplaces could pose big risks

Results from simulation of active local COVID-19 cases



Notes: Grattan's COVID-19 microsimulation model. Starting point is imputed active local cases at June 1 (see Appendix A.11.1). This chart mostly reflects case numbers in Victoria and NSW as active cases were low or zero elsewhere (Appendix B has state results). Simulations use the settings provided in Table A.2 and Table A.3 with the following adjustments:

	Left panel	Right panel
Proportion of workplaces open	90%	100%
Max number of people allowed in workplace	200	200
Secondary attack rate at workplaces	0.05	0.15

3.5 Reopening schools

By the end of March, more than 100 countries had implemented national school closures.²²³ Closing schools can limit contacts between people and households, giving a virus less scope to spread.²²⁴ But for millions of working parents in Australia, having their children at home from school is a significant burden.²²⁵ It also disrupts the education of children, particularly already disadvantaged children and those preparing for exams.²²⁶ It is a potential restriction to the spread of COVID-19 with substantial costs to society.

The literature finds that widespread closing of schools has minimal effect on the transmission of COVID-19.²²⁷ Modelling of the COVID-19 outbreak in Wuhan suggests that school closures led to a small reduction in transmission.²²⁸ In Hong Kong and Singapore, closing schools did not appear to have an impact on transmission of COVID-19.²²⁹

There is evidence that closing schools has slowed the spread of other diseases. A study looking at influenza transmission among children in France found closing schools during a pandemic reduces spread in both children and adults.²³⁰ Modelling of influenza in South-East

221. As shown below the figure and in Appendix A, this model assumes that workers do not interact with more than the maximum number of people allowed in their workplace. But most people go to work in places with fewer than 200 people: Appendix A.3.1.

222. See Appendix A.

223. Viner et al (2020).

224. Ferguson et al (2020, p. 16).

225. D. Wood and Mackey (2020).

226. Sonnemann and Goss (2020).

227. This is distinct from closing schools when a COVID-19 case has been detected.

228. Prem et al (2020).

229. Viner et al (2020). There were few studies that could separate the effectiveness of school closures from other concurrent social distancing measures.

230. Cauchemez et al (2008).

Figure 3.7: Opening schools only increases risk of outbreaks slightly
Results from simulation of active local COVID-19 cases



Notes: Grattan's COVID-19 microsimulation model. Starting point is imputed active local cases at June 1 (see Appendix A.11.1). This chart mostly reflects case numbers in Victoria and NSW as active cases were low or zero elsewhere (Appendix B has state results). Simulations use the settings provided in Table A.2 and Table A.3 with the following adjustments:

	Left panel	Right panel
Secondary attack rate same school	1 in 100	1 in 5000

Asia,²³¹ Australia,²³² Europe,²³³ the US,²³⁴ and elsewhere²³⁵ has also shown the effectiveness of school closures.

But whereas the attack rate of other influenza viruses on children was high,²³⁶ children appear less likely to get and spread COVID-19 (see Appendix A.10). Low infection rates of children mean that the impact of closing schools is likely to be minimal.²³⁷

School students interact with their classmates most, and with children in other grades less. Analysis of the in-school interactions of school children found that they interact with between 30 and 60 people during a school day, with interactions lasting between 20 and 50 minutes.²³⁸ While COVID-19 has spread among people in schools,²³⁹ evidence from Australia to date suggests that substantial outbreaks in schools are unlikely.²⁴⁰

For these reasons, the outcomes in Figure 3.7 are less dramatic than those with loose restrictions at work or in the community. If schools are open and put in place practices to reduce the likelihood of transmission, the risks of outbreaks is still relatively low. If schools are less careful – if transmission is more likely in the classroom or in the playground – this risk rises. But if schools continue to be quick to close on the discovery of a new case – as is modelled in both panels of Figure 3.7 – outbreaks are likely to be contained.

231. Ferguson et al (2005, p. 212).

232. Kelso et al (2009).

233. Hens et al (2009).

234. Halloran et al (2008).

235. Fong et al (2020, table 1); and Rashid et al (2015).

236. See for example Neuzil et al (2002).

237. Ferguson et al (2020, pp. 15–16).

238. Guclu et al (2016, table 2). See also Leecaster et al (2016).

239. National Centre for Immunisation Research and Surveillance and NSW Health (2020); SBS News (2020); and Aubusson (2020).

240. National Centre for Immunisation Research and Surveillance and NSW Health (2020).

3.6 Major events

Cancelling major events was the first action taken within Australia to prevent the spread of COVID-19.²⁴¹ The logic behind this decision is sensible: stopping tens-of-thousands of people gathering in the same place for a football game or music festival removes millions of potential contacts and chances to transmit the virus.

Mass gatherings have been the source of outbreaks for other viruses.²⁴² A systematic review of mass gatherings and respiratory disease in the US between 2005 to 2014 found that more than half of outbreaks occurred at fairs and at children's camps.²⁴³

The nature of the major event is crucial in assessing its risk. A seven-day cruise with shared indoor spaces and meals poses an obvious risk, which has been seen throughout the COVID-19 crisis.²⁴⁴ But few outbreaks were detected at sporting events, which are often held outside with ample ventilation and limited social mixing.²⁴⁵

The key concern with major events is that outbreaks in these settings can overwhelm contact tracing capacity. Recalling all the people that you had contact with at a dinner party is one thing; doing the same when you have been to a large stadium is another. Outbreaks that involve major events are difficult to contact trace, meaning isolating all the people who have potentially become infected is impossible.

3.7 Prioritising reopening

The phasing down of health restrictions depends on the current level of local transmission (discussed in the next section), the level of social

241. See Chapter 2.

242. Abubakar et al (2012).

243. Rainey et al (2016). Most of the outbreaks at camps were of Swine Flu in children in 2009.

244. Ebrahim and Memish (2020).

245. Rainey et al (2016).

adherence to behavioural change, the impact of each restriction on infection rates, and the social and economic cost of each restriction.

Our modelling suggests that careful reopening of schools won't make much difference to infection rates. Maintaining behaviours such as physical distancing and handwashing will help stop outbreaks from gathering speed and are vital if all shops and workplaces are to be re-opened. Indoor events are also likely to lead back to rapid growth of infections unless there are no local cases, or so few that contact tracing systems are effecting in containing outbreaks.

3.8 The strategic design of health restrictions

The extent of restrictions on economic and social behaviour should depend on the extent of local transmission at the time.

There are three underlying scenarios, which require different responses:

- Elimination: there is *no* local transmission – this implies that all active cases have been identified and effectively quarantined;
- Suppression: There is *some* local transmission, but the number of new cases is small, and not obviously increasing; or
- Growth: Local transmissions are evidently increasing.

3.8.1 Scenario 1: Elimination

If there are no local transmissions, governments can afford to allow all activity that would otherwise lead to new infections growing.

This may not amount to complete 'elimination', because travellers may enter with the disease, provided that they are quarantined, and care is taken to ensure that while in quarantine they do not infect anyone in the wider community.

The elimination scenario is much less restrictive than the others. It would permit 'normal' activity. A government can only afford to permit this much activity if it is confident that there really are no cases out in the community. It can only have this confidence if no new domestic transmissions have been recorded for several weeks, and border controls remain strong. And it will be more confident if it has an extensive testing regime that is more likely to identify a chain of domestic transmission that would otherwise be hidden.

Of course if most restrictions have been lifted, then any quarantine breach is likely to lead to rapid growth in infections. To reduce the potential rate of growth, a government would be sensible to keep suppression measures in place that are relatively low cost (such as encouraging people to wash their hands regularly). And a government must be ready to reimpose restrictions on activities that tend to increase transmission a lot if there is a quarantine breach.

3.8.2 Scenario 2: Suppression

If there are only a few local transmissions, a government needs a combination of restrictions and effective track-and-trace systems to suppress the growth of infections.

The disadvantage of a suppression strategy is that many restrictions must remain in place indefinitely – many more than in an elimination scenario. And government is relying heavily on its track-and-trace system being continuously effective in breaking most of the chains of infection. By contrast, under an elimination scenario, the track-and-trace system is only under pressure on the rare occasions that the disease manages to escape from quarantine.

3.8.3 Scenario 3: Growth and restriction

Track-and-trace systems inherently cease to make much difference once case numbers escalate, because it becomes practically impossible to trace all of the contacts of every infected person.

If COVID-19 escapes quarantine under an elimination scenario, or overwhelms the track-and-trace system under a suppression scenario, then governments need to have enough restrictions in place that infections do not grow rapidly in a 'second wave'. If infections do grow rapidly, community fear is likely to spread quickly and governments would need to re-impose restrictions to bring infections back under control.

3.8.4 State-based strategies

Some of Australia's states have effectively eliminated local transmission of COVID-19, and are keeping their borders closed to states where it persists. States should maintain different restrictions if they have different rates of local transmission.

Restrictions are obviously needed much less in states which have effectively eliminated the virus from their local population.

3.9 How Australia should move forward

Through decisive policy action and effective collective action, Australia finds itself in a fortunate position. But we are not out of danger yet, and must make ourselves comfortable in a new normal of restrictions and behaviour change.

The new normal will have to be in place for an extended period. At best a vaccine or cure may be available for widespread use sometime in the first half of 2021. But, despite the unprecedented international effort, there is no certainty this will happen.

The strategy will depend on whether a given area – typically set by state – has eliminated the virus, suppressed it, or still has persistent local transmission.

3.9.1 When there are no active COVID-19 cases in Australia

When there are no active cases in a community – a feat achieved by the NT in April, SA and Tasmania, and New Zealand, and WA in mid-June²⁴⁶ – more of life can return to normal. Capacity constraints on workplaces, shops, and hospitality can be removed.

But some people with COVID-19 have remained infectious long after their diagnosis, well beyond 21 days.²⁴⁷ Therefore testing must remain a routine part of life even after Australia declares itself COVID-19-free. If local cases are identified, contact tracers must be at the ready, and widespread testing should restart in affected areas.

The rest of the world is still a long way from control of COVID-19, and Australia must make sure it does not import new cases. Current mandatory quarantining of international arrivals must remain in place, and breaches prevented.²⁴⁸ The Commonwealth Government should maintain and enforce safety guidelines for new arrivals as updated information about the virus and new technology to assess infectivity of individuals is developed.

Quarantine exemptions could be made with other countries, such as New Zealand, that also have no active COVID-19 cases and that have effective international arrival practices in place.

246. Plank et al (2020).

247. Modellers acknowledge this risk in New Zealand: Plank et al (ibid).

248. Laschon (2020).

3.9.2 While there are few active COVID-19 cases in Australia

In a state that has suppressed – but not eliminated – the virus, rates of infection will depend on:

- the efficacy of testing, contact tracing and isolation;
- individual behaviour, such as handwashing, physical distancing, and mask wearing;
- restrictions on social and economic behaviour.

Given the necessities of contact tracing systems and individual behaviour, it is impossible to accurately predict how many, or by how much, social and economic restrictions can be lifted before infection rates increase, and the virus again spreads uncontrollably. The best that governments can do is make informed estimates about which restrictions can be lifted reasonably, and be prepared to reimpose some of them if it becomes apparent that local infections are growing quickly.

Testing, contact tracing and isolation, and a graduated lifting of lockdown restrictions, are likely to maintain a low rate of infection in Australia for an extended period – given how effective restrictions were when first imposed. But with low rates of infection, perceptions of risk will decrease, and social distancing and hygiene measures are less likely to be maintained. It is therefore important, while there are active COVID-19 cases in any state, that structural measures to control rates of infection over the longer term are put in place.

Even then, it is likely there will still be outbreaks and clusters. The capacity and effectiveness of contact tracing will be critical to prevent wider spread and a return to exponential growth.

The risk of opening workplaces will depend on how workplaces are opened and how people behave. Government guidelines for

businesses should be clear, and their implementation should be monitored. When there is an infection in a workplace, rigorous contact tracing, testing and isolation must be implemented. Workers who show symptoms of COVID-19 must not be allowed in the workplace, and must be supported to continue their work from home where possible, or through government support if not.²⁴⁹

If local transmission is not increasing, workplaces should be re-opened slowly, with as many people as possible continuing to work from home to minimise the number of people interacting.

A number of measures are ‘no regrets’. There needs to be continued reminders about the importance of social distancing and hygiene. Workers should keep their distance from each other, and minimise time spent in shared spaces such as kitchens.

Schools should enforce social distancing policies, to reduce risk of outbreaks before detection. If a case is detected in a school, it should be closed and rigorous contact tracing implemented.

People in the community should continue to take social distancing precautions, including wearing masks in high-risk situations. As fewer COVID-19 cases are reported and risk perceptions are lowered, people must be reminded about their social distancing responsibilities. Hand sanitiser must be available and used as part of the new normal.

Patron spacing limits in shops should be maintained if local transmission of COVID-19 continues in particular cities. The onus should be on the employer or owner of the workplace, cafe, or shop, to be aware of the risks, to have developed a safe opening plan informed by resources from government health authorities, and to enforce the

249. A ‘hardship’ payment for casual workers in Queensland was introduced in June to support people who are unable to work due to isolation: Palaszczyk and Fentiman (2020). This has been identified as a key issue for safely opening businesses in NSW: Cavanough (2020).

plan. The onus is on public health authorities to be clear about what a good safe opening plan looks like for employers and owners.

The transition from lockdown to a new normal will take some months to stabilise, as new information emerges from experience. As structural measures to manage infection are put in place, new patterns of personal behaviour are likely to follow. It will be important that there is an effective communication campaign to support, encourage, and reinforce these changes.

3.9.3 Dealing with substantial outbreaks to avoid a second wave

While there are active cases of COVID-19 in Australia, there is still a risk of a second wave. The risk is higher if policies and behaviour return to normal too soon.

State and territory governments must actively monitor cases in local areas. They must be prepared to act decisively to control major outbreaks. Exactly how they will act in the case of a major outbreak must be determined in advance by the relevant public health authority, and should be communicated clearly with the public before outbreaks occur.

If frequent testing discovers an outbreak that may overwhelm contact tracing efforts, local lockdowns should be considered.²⁵⁰ The mechanics – the threshold of cases for a lockdown, who can enter and exit the affected area, what happens to workplaces and schools – must be communicated with the public in advance of outbreaks occurring. This will ensure the public and local authorities know what to expect and how to react. It will also remind the public of the risks of COVID-19

spread: if it remains, and if there is an outbreak, lockdowns will have to return.

If these local measures fail, then the virus is likely to spread quickly if workplaces, major events and state borders have been reopened. If the virus begins to spread throughout a wider area, state and territory governments must reintroduce at least some of their lockdown restrictions to suppress infections.

250. These types of localised lockdowns have been used in China when substantial outbreaks have been discovered. After a cluster of cases was detected, linked to a market in a Beijing district, lockdown measures were put in place for the neighbourhoods surrounding the market: Hua and Cadell (2020).

4 The health system after lockdown

All Australians were affected by the coronavirus pandemic. For most, it was just the irksome restrictions as social distancing was used to drive down new cases. For many, it involved a loss of income. For some, it was mourning the death of a loved one, with the grieving made all the more painful by restrictions on the number of people who could attend the funeral.

The health system changed too. It embraced new ways of working because of the need to protect patients and staff from infection. Elective procedures were cancelled and health professionals took on new roles. Changes occurred across most parts of the health system, and were often embraced by consumers and providers alike.

It wasn't all smooth sailing. Coordination wasn't good enough and had to be built. Public health planning wasn't strong enough at the regional level. Primary care wasn't ready or properly supported to deliver the required front-line services. Telehealth wasn't ready and defaulted to telephone calls. Home care and home monitoring was not well prepared or well integrated with primary or tertiary care. The private and public hospital systems were not integrated. Rapid solutions to all these problems had to be found.

We are only part the way through the response to the pandemic and its consequences.

The experience of health care during the pandemic highlights the issues Australia needs to tackle for a more effective, efficient, and equitable health system. In this chapter, we discuss what a 'new normal' should look like. It would be a tragedy if lessons weren't learned from the pandemic. We argue that Australia should not 'snap back' to the old order, but rather that the changes that occurred during

the pandemic should inform what happens during the recovery period and beyond. This will require changes to funding and governance.

The process for change

Retaining some of the changes that were made during the lockdown is a no-brainer. But even so-called no-brainers require some thought. Almost every consumer and health professional has a story to tell about what worked and what didn't. Stewards of the system – the funders and the regulators – will also have their perspectives on how things worked, aware of the unintended or perverse consequences of policies implemented rapidly during the pandemic. All this knowledge should be tapped to design a better system, and this requires effective overarching change management processes.

The new normal will not just happen. Decisions need to be taken about what stays and in what form, lest all the good changes be eroded by a drift back to the old, inadequate ways. States and territories, and the Commonwealth Government, should establish participatory processes to plan the transition to the new normal. These processes may be a special-purpose review committee²⁵¹ or build on the task groups set up to manage the pandemic.²⁵² Whatever the structure, there should be opportunities for consumers and professionals to be involved.

COVID-19 appeared on the scene quickly, and there was a lack of evidence initially about what it was, its epidemiology, and how to treat it. The Commonwealth Government established a 'Rapid Research Information Forum' to provide evidence-based advice on topics such as the efficacy of serological tests and whether people

251. Such as Queensland has established, and in which Dr Stephen Duckett, a co-author of this report, participates.

252. The latter is the approach adopted by South Australia.

can be reinfected.²⁵³ This evidence-based approach should be carried over into the new normal. In particular, any policy changes should be informed by evidence about the impact on the most vulnerable.²⁵⁴

There are seven key areas where pandemic-related policy changes or identifiable weaknesses provide lessons for the future: telehealth; out-of-hospital care; the primary care system; the interaction between the public and private hospital systems; supply chains; public health preparedness; and overall system planning and coordination.

4.1 Lesson 1: Improve access through telehealth

Primary care played a crucial role in the preparations to fight coronavirus, stepping up without adequate supplies of personal protective equipment, and facing changing guidance on who to test, where and when, all despite initial hits to practice revenue.²⁵⁵ There was a silver lining for consumers: the introduction of telehealth, which should now become a permanent feature of health care in Australia.

Starting in mid-March 2020, the Government drip-fed changes to facilitate telehealth in primary care. Two groups of items were introduced: one for video-conference consultations, and one for telephone consultations if video was not available.

Telehealth consultations are a valuable virtual health service.²⁵⁶ Others include remote imaging services, online secondary consultations, electronic scripts, remote monitoring, online team coordination, and

electronic health records.²⁵⁷ The COVID-19 experience shows that virtual health can and should be expanded to improve patient care.

Telehealth has been advocated for decades as a way of enhancing access to care for people living in rural and remote Australia.²⁵⁸ But telehealth has faced numerous barriers,²⁵⁹ not least equivocal Commonwealth Government support,²⁶⁰ and poor internet connectivity in rural and remote Australia.²⁶¹ Take-up was low.²⁶²

Telehealth should not be seen as a simple substitute for a face-to-face consultation, although it can be that. In the new normal, health professionals and their patients need to assess when telehealth should be the preferred medium because of the nature of the problem, distance to be travelled, and other factors. The ‘digital divide’ means that a patient’s digital literacy will need to be assessed in customising care.²⁶³ Funding should be provided to develop programs to lower or remove the barriers created by the digital divide. Primary Health Networks (PHNs) would be well placed to do this, linking as they do the primary care system and populations.²⁶⁴ PHNs are able to tailor programs to different needs based on geography or community characteristics such as differences in the number of people with diverse cultural or linguistic backgrounds.

The pandemic telehealth items initially did not include secondary consultations – discussions between a specialist and a general

253. Rapid Research Information Forum (2020); and Forum (2020).

254. Pineda and Corburn (2020); Z. Wang and Tang (2020); Smith and Judd (2020); The Lancet (2020b); and Ahmad et al (2020).

255. This section draws on Duckett (2020c).

256. We have used the term ‘telehealth’ in this section because it is the most common term in current use. Over time we would expect ‘telehealth’ to be replaced by a broader term such as digital health, virtual healthcare, or ‘technology-enabled care’.

257. Fera et al (2020).

258. Bradford et al (2016); and Wells (1976).

259. Jang-Jaccard et al (2014).

260. Yellowlees (2001).

261. Bush Alliance (2018); and Park et al (2019).

262. Wade et al (2014).

263. Velasquez and Mehrotra (2020).

264. Declaration of interests: Dr Duckett is chair of Eastern Melbourne PHN; Dr Hal Swerissen, another co-author of this report, is a member of the Board of Murray PHN.

practitioner without the patient present. This service currently attracts no additional remuneration for either party, but should be expanded as part of a virtual health world. New streamlined specialist telehealth items – less complex than case-conferencing items – should be introduced to facilitate secondary consultations with general practitioners (with or without the patient present).

An emphasis on telehealth should be accompanied by 21st Century e-referrals²⁶⁵ – abandoning the fax machine which is still ubiquitous in health care but has been relegated to the recycling bin or the museum in all other industries – and getting My Health Record to be a trusted source of information for patients and clinicians alike.²⁶⁶

Telehealth is prone to a ‘woodwork effect’ – where demand comes out of the woodwork when a new benefit is available.²⁶⁷ The risks of over-servicing,²⁶⁸ misuse by some providers with predatory business models,²⁶⁹ and fraud are real,²⁷⁰ but the benefits of telehealth are undeniable. Especially in the context of increasing prevalence of chronic disease, telehealth items should enhance continuity of care,²⁷¹ which benefits patients and reduces costs,²⁷² and avoids further fragmenting the primary care system.

New telehealth items ought to have been introduced long ago. It is a tragedy that it took a pandemic to get the policy ball rolling. The issue becomes how to ensure new items are not abused; for that reason, the COVID-19 items may not be suitable for the new normal.

265. C. A. Hughes et al (2018); and Love (2019).

266. De Mesquita and Edwards (2020).

267. Sprague (2014).

268. Viney and Haas (1998); and Van Gool et al (2002).

269. Knibbs (2020a); and Knibbs (2020b).

270. Department of Justice (United States) (2019); Department of Health and Human Services (United States) (2018); Faux and Grain (2020); and Rajda and Paz (2019).

271. Including continuity of care between medical practitioners and pharmacists.

272. Pereira Gray et al (2018); and Bazemore et al (2018).

The Australian College of Rural and Remote Medicine has published a set of standards which could be used as a basis for developing revised items.²⁷³ These standards include 11 core principles, one of which is:

The integrity and therapeutic value of the relationship between client and health care practitioner should be maintained and not diminished by the use of telehealth technology. Telehealth must enhance the existing clinician/patient relationship (not fragment it). Telehealth arrangements should complement existing services (where available), build on rural workforce and referral patterns to avoid further service fragmentation, and address practicalities of coordination, scheduling and support from the patient’s perspective to improve their continuity of care.

Although framed for rural and remote practice, this principle is relevant to telehealth delivery anywhere. In line with that principle, specifically that telehealth ‘must enhance the existing clinician/patient relationship’, new telehealth items should be limited to patients with an established relationship to a practice, such as having at least half of their primary care visits in the past year to that practice.²⁷⁴ In the case of people over the age of 70, once enrolment is implemented,²⁷⁵ telehealth should be limited to the practice in which the patient is enrolled.²⁷⁶ New specialist telehealth items should be introduced for attendances other than the initial consultation.

The current items specify that telephone consultations are supposed to happen only if video is not available. Yet during the pandemic

273. Australian College of Rural and Remote Medicine (2020).

274. Practices should be able to contract with specialist telehealth providers for out-of-hours care, and it may also be appropriate to allow practice nurses to provide telehealth services for the practice.

275. As foreshadowed in the 2019 Budget.

276. In England all patients need to enrol with a general practice. The current payment contract between the NHS and general practice requires a phased expansion of telehealth, including that at least one quarter of consultations should be digital – and this was before the pandemic: see Iacobucci (2019).

telehealth, at least in general practice, was primarily by telephone (see Figure 2.6). The relative benefit of video compared to telephone consultations has not been evaluated, so governments should await evidence on the most beneficial balance for patients and providers before deciding if restrictions should be maintained.²⁷⁷ There should be a financial incentive on practices to bulk-bill telehealth items, and these items should be subject to strict electronic verification requirements.²⁷⁸

During the pandemic the structuring of telehealth items mirrored face-to-face items. In the new normal there might be quite different tiering, splitting the standard consultation item into two or three items, because there can be more accurate automatic verification of consultation length.

Digital or virtual consultations can also be by email, although the evidence about e-consultations is mixed.²⁷⁹ Nevertheless, practices should be encouraged to make e-consultations available to their patients. In the first instance, this might best be as a benefit for patients who are 70 and over who enrol with a practice. Standards for practices to be eligible to accept enrolments of patients aged 70+ should include requirements about e-mail consultations.

Telehealth is particularly useful in mental health care.²⁸⁰ Unfortunately, during the pandemic spatial isolation often converted into social isolation, and this created anxiety and psychological distress for many,²⁸¹ leading to increased mental health presentations in general

practice.²⁸² After the pandemic, there will be a further surge in demand for mental health services,²⁸³ and this will put still more pressure on an already overloaded mental health system.²⁸⁴ As with primary care, new technologies may help meet this future demand.²⁸⁵

Telehealth may have perverse effects too. Although a boon for rural and remote patients, if wider access to telehealth reduces the viability of – or trust in – specialists who are based in regional centres, it may be a net negative. Policies that limit telehealth access in a way that promotes continuity of care may reduce the risk to rural specialty practice.

4.2 Lesson 2: Encourage outreach and telehealth with new primary care funding models

Australia has taken the first hesitant steps towards new primary medical care funding arrangements, with an enrolment fee for people aged 70+ announced in the 2019 Budget.²⁸⁶ Further steps should be taken, to improve the continuity of patient care.

During the pandemic, staff in some Victorian community health centres made more 'outreach' phone calls to vulnerable patients, to motivate and encourage them, and to advise them on how to manage their condition.²⁸⁷ This type of practice should be encouraged and facilitated with a new funding model.

277. Outcome Health (2020c) proposed a system-wide target of 50 per cent of telehealth consultations to use video by 2021.

278. Faux and Grain (2020). Anecdotal evidence suggests telehealth is more efficient for providers, including by reducing no-shows.

279. Mold et al (2019).

280. This section draws on Hickie and Duckett (2020).

281. Australian Bureau of Statistics (2020b); Biddle et al (2020); and Fisher et al (2020).

282. Pearce and McLeod (2020, pp. 12–13).

283. Reger et al (2020), Outcome Health (2020a) and Brown et al (2020). Torjesen (2020).

284. Duckett and Swerissen (2020).

285. Torous et al (2020).

286. Durham (2019).

287. Innovative ways to provide alcohol and drug services were also required: Dunlop et al (2020).

Australia's GP fee-for-service funding approach inhibits new practice models.²⁸⁸ Australia still has a very doctor-centric primary care system, reinforced by our Medicare system, based as it is on fee-for-service remuneration principally of medical practitioners. This puts barriers in the way of practices using staff from other professions as part of the treatment team.

In the early stages of the pandemic there was an important contrast between the testing strategies in England compared to Australia.²⁸⁹ Nurse-led drive-through testing was established in London more than a fortnight before an equivalent strategy was adopted in Australia. The UK response was possible only because of a systematic strategy over years to focus GP time on patients who most require the diagnostic and treatment skills of a GP, and to encourage the community to seek advice about when a visit to a GP was really necessary.

Minimising GP visits is not a good business proposition for private GPs in Australia, because they get paid on a fee-for-service basis: the more patients through the door, the more revenue for the practice. But minimising GP visits makes a lot of sense in the UK, where the payment system for GPs is more sophisticated: they are paid an overall fee to manage a patient's care plan.

Payment strategies that encourage the most appropriate health professional to be involved in the care are required before practices can start to redesign their workflows.

Using nurses and other staff to provide care to patients with chronic conditions can improve patient care and increase system efficiency.²⁹⁰ Using non-specialist health workers, supported by digital technology, could also improve the care of people with mental health problems.²⁹¹

288. Duckett et al (2013).

289. This section draws on Duckett (2020d).

290. Vasi et al (2020).

291. Naslund et al (2019).

The Commonwealth Government should review the barriers in the Medicare Benefits Schedule to practices forming their workforce to ensure they deliver high-quality care more efficiently.

Funding needs to move from the current fee-for-service model towards a 'blended' model that combines fee-for-service, capitation, and commissioning for primary care.²⁹² The overarching framework for agreements should be negotiated between the Commonwealth and the profession. Agreements for individual practices should be negotiated and monitored by Primary Health Networks on behalf of local regions and communities.

Of course, changing funding arrangements is notoriously difficult – after all, every dollar of health expenditure is a dollar of income.²⁹³ But the widespread public support for some of the changes during the pandemic may give governments the spine and cover to push ahead with change.²⁹⁴

4.3 Lesson 3: Improve convenience and access with expanded out-of-hospital care

New 'virtual hospitals' were planned as part of the pandemic response.²⁹⁵ A huge variety of telehealth and telemonitoring approaches were introduced very rapidly.²⁹⁶ In this section we argue that all this should become part of a new 'business as usual'.

292. Oliver-Baxter (2015).

293. Reinhardt (2012).

294. This discussion has been about primary care. However, public hospitals should make it easier for outpatient consultations, especially follow-up consultations, to be provided by telehealth. Post-surgery follow-up by telehealth has been shown to be safe and effective, provide significant savings to patients and health care systems, and be acceptable to both patients and providers. For more on outpatient reform see Duckett (2020e).

295. Mannix (2020); and Sweet (2020).

296. Wosik et al (2020).

Hospital-in-the-home is a well-established and effective alternative to in-patient care for many conditions.²⁹⁷ Rehabilitation in the home, or as an out-patient, has been shown to be just as effective as in-patient rehabilitation for appropriately selected patients.²⁹⁸

COVID-19 had a very significant impact on residential care, accounting for about 30 per cent of deaths in Australia and 30-to-50 per cent of deaths worldwide. The pandemic caused many nursing homes (residential aged care facilities) to go into lockdown and reduce visitors and transfers in and out of hospital care. There is now well-established evidence of the benefits of hospitals providing additional support to residential aged care facilities, including via telehealth,²⁹⁹ to reduce hospital admissions.³⁰⁰

States should expand hospital-in-the-home and rehabilitation-in-the-home services, and outreach into residential aged care facilities.³⁰¹

Medical practitioners cannot bill Medicare for services provided to public hospital hospital-in-the-home patients. However, involvement of a patient's general practitioner should be encouraged to ensure continuity of care. Public hospitals should contract with general practitioners to pay them for their services to those patients. This could be facilitated by Primary Health Networks.

States with plans to expand public hospital bricks and mortar should review those plans to assess to what extent out-of-hospital and telehealth expansion might obviate the need for some of these builds.

297. Caplan et al (2012); and Kansagara et al (2016).

298. Schilling et al (2018).

299. Hui et al (2001).

300. Chan et al (2018); and Carter et al (2019).

301. Hospital-in-the-home services may need to be tailored to be culturally appropriate for all communities: Brett et al (2017).

Telemonitoring is an important aspect of hospital-in-the-home. It reduces costs,³⁰² and appears not to reduce quality of care for the most vulnerable.³⁰³

More telemonitoring will require viable business models, either through new Medicare Benefits Schedule items, again perhaps linked to enrolled patients, or as part of hospital outreach, with costs shared between the Commonwealth and states under public hospital funding arrangements, as a non-admitted service.³⁰⁴

4.4 Lesson 4: Improve efficiency by connecting the public and private systems and better managing elective procedures

Public hospitals were transformed during the pandemic as they responded to an anticipated tsunami of demand.³⁰⁵ Beds were freed up as a near total shutdown of elective procedures was ordered. This latter strategy increased average total waiting times for surgery, and created a 'care debt' of delayed procedures, most of which will need to be performed in the future. This section discusses how this 'care debt' can be addressed.

Making better use of private hospitals

The private hospital system took a battering during the pandemic. Private hospitals were effectively closed for a month,³⁰⁶ and their viability may be under pressure. But the pandemic showed that it was possible to integrate public and private care. Every state and territory negotiated contracts with private hospitals to provide 'overflow' care in case public hospitals were overwhelmed.

302. Michaud et al (2018).

303. Jennett et al (2003).

304. For example, as a 'clinical monitoring service'.

305. This section draws on Duckett (2020f).

306. Morton (2020).

Unemployment has risen, which may cause people to reflect on whether they can afford to maintain their private health insurance. Funds' cash position has been improved by the slow-down in elective procedures, and in visits to health professionals covered by general (extras) insurance. But if younger people, hit hard by increased unemployment, decide to drop their insurance, the industry's 'death spiral' will accelerate.³⁰⁷ Fewer people insured would mean less demand for private hospitals from private patients.

States should consider negotiating long-term contracts with private hospitals, so that procedures can be performed in these hospitals to help clear the elective surgery backlog. States should also consider this strategy to meet future demand for elective procedures.

Managing demand for elective procedures

If there is to be increased public contracting of private care, it needs to be equitably managed.

A properly managed elective procedures system should have three key elements:

- there should be a consistent process for assessing a patient's need for the procedure, and ranking that patient's priority against others;
- the team performing the procedure, and caring for the patient afterwards, should be highly experienced in the procedure; and
- the procedure should be performed at an efficient hospital or other facility, so the cost to the health system is as low as possible.

Unfortunately, Australia sometimes fails on all three measures.

307. Duckett and Nemet (2019a); and Duckett and Cowgill (2019).

There is no consistent assessment process across hospitals. Even different surgeons in the same hospital seeing the same patient sometimes make different recommendations about the need for a procedure. This means a patient lucky enough to be seen by surgeon A may be assigned to category 2, but the same patient seen by surgeon B might be assigned to category 3 and so have to wait longer. A patient's gender or level of education sometimes seems to have an inappropriate effect on categorisation decisions.³⁰⁸

Assessment is a core skill of specialists and there will always be legitimate variation in recommendations for treatment to take account of the individual circumstances of each patient. However, the point here is to ensure that variations in assessment and prioritisation reflect patient-specific factors and are evidence-based.

States should develop agreed assessment processes for high-volume procedures, such as knee and hip replacements and cataract operations, and reassess all patients on hospital waiting lists. Reassessment could be done remotely using telehealth.

Standardised care paths improve care and equity

Specialists in each area, together with referring clinicians, should be invited to develop evidence-based criteria for setting priorities and for developing agreed care paths.³⁰⁹ The care paths should cover pre-surgery care (e.g. what diagnostic tests should be done, what non-surgical treatments should be tried before the procedure),³¹⁰ and post-surgery care both in-hospital and at home.³¹¹ Standardised care paths, such as the New South Wales Agency for Clinical Innovation's

308. Smirthwaite et al (2016).

309. Breton et al (2020).

310. Schoch and Adair (2012); and Glasgow et al (2020).

311. Care paths should also specify who might do what as part of workforce reform, see Erhun et al (2020).

Osteoarthritis Chronic Care Program,³¹² have been shown to lead to better outcomes and reduced admission rates.³¹³ Care paths should build on the extensive work on care paths done by Primary Health Networks, to help ensure smoother transition from primary care (general practice) to secondary care (hospitals) and back again.³¹⁴

A substantial proportion of patients in even the most specialised medical centres can be treated according to a standardised care path.³¹⁵ Care paths should be developed by multidisciplinary teams, to ensure non-medical treatments are appropriately considered.³¹⁶

Private health insurers should be empowered to participate in funding diversion options, so patients are able to have their rehabilitation at home rather than in a hospital bed.³¹⁷

A new, coordinated, single waiting list priority system in each state would enable all patients to know where they stand.³¹⁸ A patient on the top of the list would be offered the first available place, regardless of whether it was closest to their home. They could refuse the offer, without losing their place in the queue, if they wanted to wait for a closer location or to be treated by a team with whom they have a relationship.³¹⁹ Queueing theory suggests that a single waiting list will lead to shorter average waiting times overall.³²⁰ And 'single-entry' models appear to improve patient care.³²¹

312. New South Wales Agency for Clinical Innovation (2020).

313. Deloitte Access Economics (2014).

314. X. J. Lee et al (2019); Gill et al (2019); and Love (2019).

315. Cook et al (2014).

316. Ackerman et al (2020).

317. Duckett and Nemet (2019b).

318. A similar proposal has been advanced for Canada, termed a 'single entry model', see Urbach and Martin (2020).

319. Or a particular surgeon or medical proceduralist if they are to be treated privately.

320. Breton et al (2020).

321. Damani et al (2017).

The single waiting list should include both regional and metropolitan patients, to ensure as much as possible that city patients do not get faster treatment than people in regional and remote areas, or vice versa. The system should be further centralised in metropolitan areas. The full range of elective procedures should not be re-established in every hospital.³²² Some surgeons would need to be offered new appointments if elective surgery in their specialty was no longer being performed at the hospital where they previously had their main appointment.

Patients with private health insurance can opt to be treated as a private patient in a public hospital. So the waiting list should include public and private patients, to prevent private patients gaining faster admission to public hospitals.

4.5 Lesson 5: Improve health system readiness by better planning

Australia's health system preparedness was put to the test during the COVID-19 pandemic. Despite Australia's largely successful response to the pandemic to date, the crisis has exposed some key weaknesses in governance, capacity, surveillance, and post-pandemic planning.

4.5.1 Governance

Australia's pandemic preparedness regime – at a national and local level, and across health and non-health sectors – helped guide Australia's response to the COVID-19 crisis. But some of the arrangements made and decisions taken were outside Australia's existing pandemic preparedness plans, because the existing regime did not adequately address the scale of the crisis. This meant the governance approach tended to be reactive, and this contributed to

322. We have discussed the benefits of concentrating procedures in high-volume centres in a previous report: Duckett and Nemet (2019b).

mixed messaging (see Chapter 2), confusion about responsibilities, and a slower-than-ideal government response.

The *Australian Health Management Plan for Pandemic Influenza*, most recently revised in 2019, did not contemplate the scale of the COVID-19 pandemic. The operational plan included simplistic response phases (Initial Action Stage, Targeted Action Stage, and Standdown Stage), which did not include the possibility of harsh measures such as international border closures, or mandatory self-isolation and quarantining of individuals. The plan assumed a 'business as usual' approach to governance, designating the Council of Australian Governments (COAG) to lead national cooperation. Instead, the Prime Minister created the novel National Cabinet during the peak of the COVID-19 crisis, to enable a nimbler national response.

The *Australian Health Sector Emergency Response Plan for COVID-19*, released in February 2020, was adapted from the 2019 plan. But the 2020 plan was less comprehensive than the 2019 plan and failed to take account of the different constitutional responsibilities of the Commonwealth Government and the states.

The mixed messaging about the pandemic extended to some confusion at all levels about who was responsible for particular decisions. Parents and teachers were rightly initially confused when Commonwealth ministers encouraged parents to send their children to school despite this being in defiance of state public health directions. Preventive actions and outbreak control in residential aged care facilities was also not handled well because of confusion in some cases about the role of the funder and quality regulator – the Commonwealth – and the overarching public health regulator – the state.³²³

323. Many residential aged care facilities also limited visitor access, exposing a risk of allowing poor-quality care because of reduced opportunities for families to observe care. Neither the Aged Care Quality and Safety Commission nor the states appeared to increase their surveillance activities through Official Visitors or other mechanisms.

The Senate and several state parliaments have established reviews of responses to the pandemic. The shortcomings of the initial governance approaches must be identified, and the lessons learned.

4.5.2 Capacity

State governments took significant steps to reduce demand on the health system, and increase its capacity, during the crisis. Governments suspended non-urgent elective surgeries and prepared to partner with private hospitals. Specific primary care practices were designated as COVID clinics, albeit slowly, to protect health workers and ensure routine health services could continue. State public health units were quickly expanded to enable comprehensive testing and widespread contact tracing (e.g. in Victoria, the contact tracing team was increased from 57 people to 1,000 people).³²⁴

But the pandemic exposed the Commonwealth Government's inability to quickly increase health system capacity. State governments have boots-on-the-ground capability that enables them to quickly boost capacity; the Commonwealth Government does not. The Commonwealth announced on 11 March that it would establish 100 GP testing clinics (in addition to state testing clinics). But these clinics were not fully operational until two months later, after the crisis had peaked.

As highlighted in Section 2.2.2, the National Medical Stockpile did not have adequate supplies,³²⁵ and governments were too slow to secure additional personal protective equipment (PPE) and testing kits. As a consequence, there was a temporary shortage in supply of testing kits and PPE during the peak of the crisis, hampering the health system's capabilities.

324. Preiss and McMillan (2020).

325. Senate Select Committee on COVID-19 (2020b); McCauley (2020).

Governments were also slow to ready for expansion of intensive care units (ICUs), despite significant growth in case numbers and clear projections that ICUs could be overwhelmed in the absence of tight lockdowns.³²⁶ By the time ICU capacity was significantly increased, case numbers had begun to decline and so the additional capacity has not been used.³²⁷

Governments faced significant challenges when trying to acquire more ventilators and PPE, and substantially increase clinical and nursing staff.³²⁸

The health system's ability to boost capacity quickly in a crisis³²⁹ is becoming increasingly important. Not only are the risks of pandemics potentially increasing (see Section 4.1), but there are increased health risks from droughts, heatwaves, bushfires, floods, and other natural disasters, exacerbated by climate change.³³⁰

Australia needs better public health planning, with clear roles and responsibilities for Commonwealth and state governments. In particular, states need to review their ICU strategies to prepare for surges in demand.³³¹ These strategies should include plans for

326. Moss et al (2020). This problem was highlighted, for example, in a 2004 Australian Government research paper on Australia's capacity to respond to an infectious disease outbreak: Brew and Burton (2004).

327. Similarly, many hospitals continued to hold beds and staff available for a surge of admissions well after lockdown restrictions were being lifted.

328. Senate Select Committee on COVID-19 (2020a, p. 17).

329. Or to prioritise necessary activity. We have discussed in a previous report the issue of no- or low-value care: Duckett et al (2015).

330. CSIRO and Bureau of Meteorology (2018). See also Duckett et al (2014, section 1.6).

331. This was also recommended in the review of Australia's health sector response to pandemic (H1N1) 2009. It recommended that governments develop a health sector surge capacity strategy to address the anticipated increase in demand for health services during a pandemic, and the need to sustain provision for long periods: Health and Ageing (2011).

rapid access to PPE supplies through improved supply chains (see Section 4.6). A workforce strategy should enable quicker training of health workers, enable quick regulatory changes to create a surge workforce, allow students to be brought into the workforce early,³³² and allow deployment of workers from less-affected regions.

Pre-pandemic planning should also ensure there is a central communications mechanism in place for primary care, to streamline consistent messaging from state and Commonwealth health authorities, Primary Health Networks, the Australian Medical Association, and the RACGP.

4.5.3 Surveillance

The pandemic exposed weaknesses in Australia's disease reporting system. Through the first few months of the crisis, there was no nationally coordinated approach to publicly releasing real-time data on confirmed COVID-19 cases and deaths.³³³

Australia's pandemic preparedness regime should include a national surveillance strategy for the collection, analysis, and reporting of data at a national level, and should build on existing surveillance systems.³³⁴ Quick and accurate reporting of data would also help decision makers and health professionals, improve testing and contact tracing regimes, and provide clearer information to the community.

332. Tonkin and Fletcher (2020).

333. Surveillance of notifiable diseases, including COVID-19, is undertaken by state and territory health authorities. During a pandemic, especially during the early stages, more detailed information is needed than what is provided through the National Notifiable Disease Surveillance System. The National Disease Surveillance Plan for COVID-19, released in May, supports more comprehensive surveillance activities: Department of Health (2020g).

334. A surveillance plan at national level was also recommended in the review of Australia's health sector response to pandemic (H1N1) 2009 (recommendation 8): Health and Ageing (2011).

4.5.4 Post-pandemic planning

Australia's pandemic preparedness regime fails to recognise that the end-state is not 'back to normal', but a 'new normal'. The secondary health effects of a pandemic, such as mental health problems, alcohol and drug use effects, and increased incidence of domestic violence, should be incorporated into pandemic planning.³³⁵ The final response phase of a pandemic plan should not be 'stand down' but should incorporate management of the conditions that arise during and after the immediate crisis.

4.5.5 Public health preparedness lessons

Australia needs to review its public health preparedness, to ensure the lessons learned from this pandemic are embedded in national and state health emergency planning. This will ensure a better response to any potential second-wave outbreak of COVID-19 infections, and to any future outbreak of a new infectious disease or other crisis event. Australia's preparedness regime should ensure sufficient flexibility to enable the response to be adapted to the specific nature of any future crisis.³³⁶

335. Although mental health effects are noted to varying extents in Commonwealth and state pandemic plans, there is limited planning for these issues in the post-pandemic phase, and no consideration of other secondary health effects such as domestic violence. The National Mental Health and Wellbeing Pandemic Response Plan released in May 2020 is an example of a more comprehensive longer-term plan that should have formed part of pandemic planning: Australian Government (2020).

336. This was a key recommendation in the review of Australia's health sector response to pandemic (H1N1) 2009 (recommendation 1): Health and Ageing (2011).

4.6 Lesson 6: Increase the resilience of the health system through supply chain reform

The pandemic created shortages of essential equipment as supply chains fractured. In this section we propose supply chain reforms to tackle the identified problems.

The supply chain mantra for the past few decades has been 'just-in-time'. The most efficient supply chain was thought to be where no – or close to no – stock was held by the company, and deliveries would be made if and when new stock was required.

But the just-in-time strategy assumes a resilient supply chain and, with many products sourced from China, this proved not to be the case during the pandemic. COVID-19 exposed the 'interlocking fragility of globalisation',³³⁷ as production and delivery times grew longer and a global surge in demand increased competition for critical items such as personal protective equipment.³³⁸

Building supply chain resilience does not mean abandoning the just-in-time strategy, but it does require more attention to the risks of not holding stock,³³⁹ and to building organisational resilience to be able to manage supply chain risks.³⁴⁰ State supply agencies should review the vulnerability of their supply chains and build 'intrinsic' resilience by making the demand side of the chain stronger.³⁴¹

Building a more resilient supply chain will involve a combination of strategies, including:

337. Whoriskey (2009).

338. Betcheva et al (2020).

339. Balancing the cost of holding stock against the cost of smaller, more frequent orders, Duckett (1987).

340. ShakirUllah et al (2016).

341. Briano et al (2009); and Saenz and Revilla (2014).

- giving a greater price premium to local supply and manufacture;³⁴²
- rewriting contracts to increase obligations on suppliers to ensure continuity of supply;³⁴³
- increasing product standardisation across the health system to allow easier substitution of products and to reduce the cost of inventory;³⁴⁴
- increasing flexibility by spreading the supply chain across more than one supplier;³⁴⁵
- ensuring that the national ‘stockpile’ is reviewed regularly to ensure it contains the right mix and quantity of products (for example, the Australian ‘stockpile’ at the start of the pandemic included masks but not gowns).³⁴⁶

A resilient supply chain also needs skilled procurement offices that can quickly establish links to alternative sources of supply if the supply chain breaks.³⁴⁷

States and territories should cooperate on these strategies. For example, economies of scale might suggest that masks be produced in one state, and gowns in another. Similarly, one state might source

342. We are not recommending that the old ‘defence industries argument’ for tariff protection be revived: Corden (1958). Australia’s health supply chain will always involve significant reliance on imports, especially from the US: McVicar and Iles (2020).

343. The New Zealand pharmaceuticals and prosthesis purchaser, PHARMAC, has adopted this strategy.

344. Sheffi (2005).

345. Ibid.

346. The term ‘stockpile’, while used widely, is inappropriate. It conveys the impression of a static stock, when it should be thought of more as a ‘reservoir’ where supplies are added and dispatched in line with expiry dates to avoid wastage.

347. The Commonwealth Department of Health replied on a private group to procure additional testing kits during the pandemic.

its needs in one country, while another might source from a second. A reactivated Council of the Australian Federation, operating separately from the new, more tightly focused, National Cabinet, might be an appropriate forum to auspice this work.

4.7 Lesson 7: Bring it all together with integrated regional planning and system management

Australia’s health care system worked differently during the pandemic. Ossified structures and processes were swept away when it became clear that without dramatic action, hospitals could have been overwhelmed by mid-April.³⁴⁸ Vested interests lost a lot of their power and a new era of Commonwealth-state relations dawned as the national interest trumped petty squabbling.³⁴⁹

In this section we propose reforms to Australia’s dysfunctional federal system to improved on-the-ground coordination.

The upgrading of the meeting between the Prime Minister and state and territory leaders – from a fractious talkfest convened at the whim of the Prime Minister and known as COAG, to a National Cabinet initially meeting at least once a week – was a critical advance.

Constitutional responsibility for dealing with the pandemic is split between the Commonwealth – essentially responsible for border control including international quarantine, the economy, and taking a lead on primary care – and the states and territories, responsible for public health including lockdown rules, emergency management, and management of public hospitals and schools. The National Cabinet was therefore essential if there were to be even a semblance of consistency across the country.

348. Moss et al (2020); and Duckett and Mackey (2020a).

349. This section draws on Duckett (2020g).

Under normal circumstances, the Commonwealth Government uses its greater fiscal power to push its agenda. Commonwealth ministers can and did opine at length about what the lockdown provisions ought to be, or whether schools should open, but the decision makers on both of these critical issues were state and territory leaders accountable to their own electorates. This is despite the Commonwealth's declaring a state of emergency under its *Biosecurity Act*.³⁵⁰ If the Prime Minister and Commonwealth ministers were to exercise any influence, a structured forum needed to be created, and it was.

National Cabinet may have worked so well because it was a meeting of equals, each with their sovereign responsibilities, with the state and territory leaders not mere supplicants looking for Commonwealth largess.

The pandemic also highlighted a consequence of the development of a 'market state', at the national level.³⁵¹ As a consequence of this hollowing out of direct service delivery and the mantra of 'steering not rowing',³⁵² the Commonwealth Department of Health operates primarily to fund states or private businesses – it performs almost no direct service delivery and it has only limited capacity to coordinate local activity. During the pandemic it used the Primary Health Networks (PHNs) as local coordinating agencies, including for distributing masks, but the PHNs are intentionally small and operate as 'commissioning' rather than delivery agencies.

In contrast, the states and territories run things, most notably public hospitals. They have public health staff who could be deployed to

perform contact tracing. The states and territories quickly mobilised their services to respond to the pandemic. They were quicker than the Commonwealth to establish new testing and treatment clinics and reprioritise hospital work.

The contrast between the Commonwealth, which relies on markets to effect its policy objectives, and states, which have more hierarchical relationships with public hospitals, was stark.³⁵³ When asked to jump by states, public hospitals said 'how high?'³⁵⁴ When the Commonwealth asked services to jump, the response was often 'how much will you pay me?'³⁵⁵

This difference in broad strategy and favoured modes of interacting hindered the speed with which the Commonwealth could respond on the ground to the new health care challenge compared to the states.

A grand realignment of responsibilities of the Commonwealth and states is regularly proposed but it patently has not been achieved. In its absence, PHNs play a role in integrating regional planning and system management.

There is currently little regional planning and coordination of primary care services, even for services funded under programmatic rather than fee-for-service funding. Where the Commonwealth funds agencies, it does so in tightly defined 'silos'. State-funded services have to adapt whenever a new Commonwealth silo is created. There is no agreed policy framework between the Commonwealth and the states for the range, scope, and eligibility of primary care services, nor for their funding and regulation or governance and management.

350. The powers of that Act are constrained to be within the areas of Commonwealth responsibility in the Constitution. The Commonwealth Minister made only two declarations using his emergency powers under the *Biosecurity Act*, one relating to a ban on cruise ships and the other on overseas travel. See Maclean and Elphick (2020).

351. Robison (2006); and Knafo (2019).

352. Osborne and Gaebler (1992).

353. For a discussion of the benefits of markets compared to hierarchies see the work of Nobel Laureate Oliver Williamson, e.g. Williamson (1975).

354. Victoria was also able to mobilise its network of community health centres.

355. Le Grand (2020).

It is common for both levels of government to fund the same service types for the same populations, with little reference to one another. Community mental health services, alcohol and drug services, community health services, and general practices are required to adhere to different service models, funding arrangements, and accountability and reporting requirements. This leads to confusion, duplication, and inefficiency, and creates gaps that people in need fall through.

We have argued above that re-opening elective surgery should be different post-pandemic from what it was before. Specifically, we argued for a renewed focus on the care paths from primary care to hospitals. This will require enhanced engagement between hospitals and primary care, which again points to the need for mechanisms to ensure better coordination between the two sectors.

There is no overarching set of agreements between the states and territories to define the role of PHNs. PHNs have limited budgets, authority, and capacity to plan, coordinate, and influence the development of primary care. As a result, in practice, the primary care system is largely unmanaged.

This needs to change. The good news is that some of the architecture required is already in place.³⁵⁶ Both levels of government are committed to bilateral agreements to improve care and reduce hospital admissions for people with complex and chronic conditions. The recently signed variation to the National Health Reform Agreement for 2020-2025 has specific proposals for 'Joint Planning and Funding at local level'.³⁵⁷ These arrangements need to be strengthened by an overarching policy that pulls the Commonwealth and pushes the states towards improvement in every part of Australia.

Primary care agreements should be struck between the Commonwealth and each state. Agreements should specify the investment the Commonwealth and the state will make to improve primary care for patients. Targets for reducing hospital admissions should be set. Performance should be monitored and the Commonwealth, the state, and the PHN held accountable for progress.

As part of the new Commonwealth-state agreements, specific tripartite agreements should be struck with every PHN around Australia. These should specify funding and results targets, and commit the Commonwealth, the state, and the PHN to specific local system changes to improve patient care and reduce potentially preventable hospital admissions. These tripartite agreements should provide a new basis for cooperation between Commonwealth and state governments, helping to overcome the disjunctions caused by Australia's fractured federalism.

PHNs have played a central role in delivering the Commonwealth's pandemic measures at the local level, but until now their importance has not been recognised. In future they will need to be strengthened, more closely integrated with state public health and acute services, and freed from some of the bureaucratic shackles that constrained them before the pandemic.

356. This section draws on Duckett et al (2017).

357. Council of Australian Governments (2020).

Appendix A: Modelling the spread of COVID-19 in Australia

A.1 The importance of modelling COVID-19 spread

Modelling plays an important role in our understanding of how disease spreads. It helps us understand the impact of past decisions, and allows us to peer into possible futures to plan ahead.³⁵⁸

While the UK was pursuing a herd immunity strategy in early March 2020, the Imperial College COVID-19 Response Team released simulation-based modelling showing the proposed plan would overwhelm hospitals and cost more than 500,000 lives.³⁵⁹ Their model's results made clear a disastrous likely scenario, and policymakers abandoned this folly.

In Australia, the Doherty Institute of Infection and Immunity and the Melbourne School of Population and Global Health developed models for the Commonwealth Government. As COVID-19 started to spread in China and beyond, researchers developed models of the virus' potential spread through the Asia Pacific region, to inform decisions on travel restrictions.³⁶⁰

As the virus landed and began to take off in Australia, these researchers provided a mathematical model that demonstrated the potential spread of COVID-19 and its impact on our healthcare system.³⁶¹ This helped guide the Government's decision making outlined in Chapter 2.

Mathematical models have since been used to estimate the effect of our combined lockdown measures, showing that delaying the lockdowns by a week would have resulted in a five-fold increase in

total COVID-19 infections in Australia.³⁶² Others have been developed to forecast infection rates around the world.³⁶³

Researchers at the University of Sydney also developed a microsimulation model which showed the levels of social distancing Australia would need to curtail the rapid spread of the virus.³⁶⁴

A.2 Grattan's microsimulation model of COVID-19 spread in Australia

Grattan Institute has developed a microsimulation model to assess the risks of lifting each of the existing restrictions.³⁶⁵ Our model estimates the effect of government policy decisions for school, work, and recreation on COVID-19 infection rates for individuals. It then aggregates these results for different geographic areas.

The starting point for our model is the Australian population, distributed in 'statistical areas' around the country. Demographic data on 2,310 Australian statistical areas (SA2s) with populations of about 10,000 people, about the size of suburbs, is used from the 2016 Census.³⁶⁶ People go to work or school. They go to the shops, and to cafes and restaurants. At night, they go home; some to their families or housemates, others alone.

At each of these places, they come into contact with others. We calculate the number of people they interact with based on their setting. Workplace size is based on ABS business data; the size of schools

358. Peng and Currie (2020).

359. Ferguson et al (2020).

360. Shearer et al (2020).

361. Moss et al (2020).

362. Marschner (2020).

363. Phillips et al (2020).

364. S. L. Chang et al (2020).

365. The model can be accessed at Parsonage and Mackey (2020).

366. ABS (2016).

is based on data from the Australian Curriculum, Assessment and Reporting Authority (ACARA).

We retrieve the location of shops, cafes, and restaurants from Google Places. Each person attends places in their area a pre-defined number of times – some people will go to the shops three times a week, for example, and others less so. The more people in an area going to the shops at a particular hour of the day will determine the number of interactions in these places.

We retrieve a person's household size and type from the ABS. A household of two adults and one child might, on a given day, interact with the people in two workplaces, one school, and a shop, before the three come home and interact with each other.

Each of these interactions carries risk of transmitting infections or being infected. These risks are determined by the likelihood of infection given an exposure to a case at home, school, work, or in the community.

If a person is exposed to the virus and becomes infected, the virus will build up in their body for a number of days during their incubation period until they start to show symptoms (Appendix A.8.2).

They will start to shed and spread the virus to others they interact with during their infectious period, often before symptoms start to show, and will continue to do so until they no longer have the virus.

An infected person may remain without symptoms for the duration of their illness. Others will develop symptoms at the end of their incubation period. As the illness progresses, some will require hospital treatment, some in an ICU (Appendix A.9). A small minority of these cases will die. This risk will change depending on a person's age.

The epidemiological characteristics of COVID-19 determine its spread and severity: the length of the incubation and infectious periods, the secondary attack rates, the severity or absence of symptoms, and the

apparent difference in children compared to adults. These inputs into our model are discussed in Appendix A.8.

The following subsections outline this process in more detail. Our model, CREMA, is a dynamic microsimulation model of Australia. The model is written in R and Rcpp.

The purpose of the model is to show the effect of policy changes on the spread of infections throughout Australia, under a flexible set of epidemiological assumptions about the disease. By necessity, the model also 'nowcasts' the number of active cases from official reports of new infections and their sources.

CREMA does not model the effect of overseas arrivals, only new infections arising from local transmission. It also does not estimate new infections arising from breaches of quarantine. While a large majority of Australia's COVID-19 cases arose from these sources (see Figure A.1), the policy response to these threats was not contentious.

A.3 Static data

The model runs on a static data table, each row a person in Australia, which identifies each person's

1. state and SA2,
2. age,
3. household,
4. school, and
5. labour force status.

For performance reasons, data are cached before being passed to the dynamic model. The cache includes the static data. Other features of each person are also cached (or "generated at cache time").

The other cache time variables are `SupermarketTypical` and the workplace variables. `SupermarketTypical`, if an individual's SA2 contains zero supermarkets, takes a value of zero (meaning the person does not visit a supermarket). For implementation convenience,³⁶⁷ if the individual's SA2 contains more than eight supermarkets we exclude all but eight supermarkets. We then randomly assign each person to a 'typical' supermarket for the person to visit during the model run.

A.3.1 Assignment of individuals to workplaces

While we are confident about the distribution of labour force status among the population we assign in the static data, we do not know how large each worker's workplace is. To model this, for each destination zone we construct a sequence of geometrically distributed random variables with parameters $1/\beta = 1/15$, where β is the rate parameter, shown in Figure A.2.

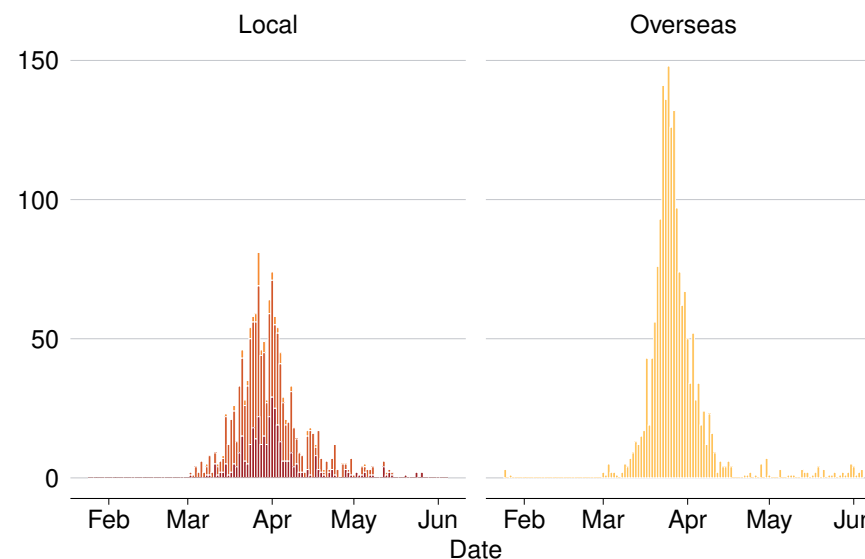
Note that the geometric distribution is used to model the number of businesses of a given size. Larger businesses are less common but hold more workers.

The number of random variables to generate is determined algorithmically: if the next random variable would overflow into the next destination zone (DZN), we fill the rest of the sequences with 2, which has the useful side-effect of inflating the number of partnerships to a number consistent with observation. With this sequence we obtain, for each working person, a group of workers associated with each person and the size of their workplace.

367. **Implementation convenience** means that the choice was not made on the basis of research, but rather because it was necessary to do so but was not considered sufficiently important to make more than an arbitrary decision. In this case, the choice of 8 was made to avoid stack overflow.

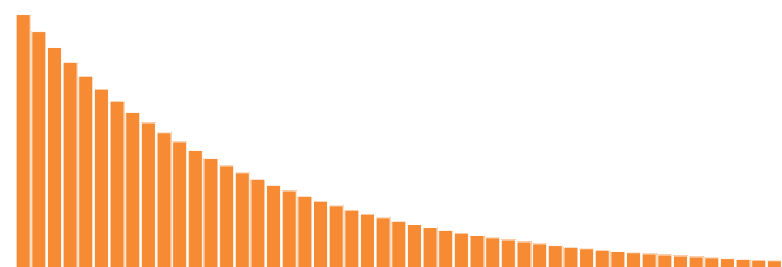
Figure A.1: Most new infections were from new arrivals, or coincided with the peak in overseas cases

New cases, by source



Source: Barry (2020).

Figure A.2: The geometric distribution with mean 15 over [0, 50]



Assignment of workplace information completes the data generated at cache time. All other personal features are constructed anew at runtime.

A.4 Modelling length of communicable period and illness

Our next step is to construct vectors to reflect the user-supplied epidemiological parameters governing the duration an infected person may be infectious and the duration of their illness. We construct for each person the duration of their communicable period and illness should they be infected when the model starts. Although it would seem wasteful to generate these values for every person, even if only a fraction of a percent of the rows are likely to be used, it so happens that this is more efficient than constructing them ‘just-in-time’, mostly because the model can perform large parts of its operation across the population in parallel, during which time the generation of random numbers is more difficult to coordinate.

The generation of the Poisson and log-normal distributions are done in the normal way using standard functions from the `stats` package. For efficiency, we construct a small vector then use `rep_len` to replicate it along the height of the data table. For example, if a Poisson distribution with parameter $\lambda = 5$ is requested, we construct the vector

```
rep_len(rpois(131059, 5), nrow(aus))
```

For the Cauchy distribution, we implement our own version to allow for parallelized random number generation with an R seed. The Cauchy distribution is characterized by infrequent extreme values so taking a small sample and repeating it was not adequate for this task. Since the Cauchy distribution has support over negative values, we use the absolute value.

In addition, we construct a **Resistance** vector which simulates the natural resistance throughout the population. Persons of the same age have the same resistance, and is determined by a user-supplied vector of length 101 which gives the proportion of individuals aged 0-100 who are naturally resistant. The default values used in our modelling are 85% resistance for 0-year-olds, 40% resistance for 100-year-olds, and a linear interpolation in between.³⁶⁸

A.4.1 Reconstructing patient histories from the starting point

The model accepts a starting date as an input, as an alternative to supplying the number and distribution of active and inactive cases in the population. To determine the number of active and inactive cases from a given starting date, we use a time series of each state's cumulative cases, together with assumptions about the source of each infection, and the epidemiological parameters that govern the duration of each person's illness.³⁶⁹ While some states report recoveries and sources of infections, this information is not reported consistently (if at all) throughout the period. Hence we are only able to *estimate* the number of active cases at a point in time, even if we take the data at face value. We assume that the cumulative number of cases by date is correct, and we use the day-on-day difference of this number to reckon the number of new cases. To each new case we assign a random member of the state's population and, using the communicable and illness vectors allocated previously, determine the dates on which the case was active.

Since a large number of new cases were from overseas arrivals, and since such individuals are more likely to be quarantined from the population, we also need to estimate how many of the above cases would be in quarantine (and thus excluded from the model). We use

368. See Appendix A.10.1.

369. The time series data is from https://github.com/pappubahry/AU_COVID19, who compiled the data from the state and territory health departments.

the NSW and Victorian time series of infection sources to impute an overall percentage of new cases on a given date that would be isolated and apply this percentage to all new cases to determine the number of new cases that exist in the wider community. On certain dates, in certain states, the number of cases reported to have an overseas origin appears to exceed the *total* number of cases. In addition, the number of overseas cases is higher for earlier dates and becomes a less common source of infection after March. To moderate these effects, we subtract the corresponding numbers of recovered patients in NSW and Victoria from both the number of overseas infections and the number of infections overall. We then take the average of the two percentages as the overall percentage of quarantined new infections on a particular date. The number of deaths at the starting point is determined by the time series of deaths by state.

Otherwise, if the `InitialStatus` input is set, it is used to construct the initial status directly.

A.5 Pseudo random number generator

Like most models of this nature, random number generation is both a core element and a performance bottleneck. We use a pseudo random number generator (PRNG) devised by Lehmer:³⁷⁰

$$x \mapsto \frac{(x \times 15750249268501108736)}{2^{64}}$$

The simplicity in the formulation makes seeding and parallelism relatively straightforward. We initialize the PRNG with a state space of twenty 128-bit integers and simply cap the number of threads at twenty whenever the PRNG is used. This array is seeded before each

day, using R's PRNG's default state, the integer vector `.Random.seed` via the `dqrng` package.

When the user requests single-threaded operations, a single 128-bit integer is used for the state and seeded in the same technique as Lemire.

To obtain Bernoulli random variables (as when applying transmission probabilities), we unpack the random number into `unsigned char` values as required. This approach reduces the loop iteration by a factor of eight, though leads to data dependencies within each pack (indeed along adjacent packs or every sixteen numbers). While this weakens the randomness of transmission probabilities among adjacent persons, this lack of independence dwarfed by the simulation's dependence on the precise initial state. Since the only way to reduce errors arising from unlucky choices of initial state (such as all infectious cases occurring in a single suburb, or all infectious individuals being in single-person households) is to increase the raw number of simulations, the performance gains were deemed to be worth this infelicity.

Although most of the parallelism is embarrassingly parallel or simple reductions, we expect the OpenMP compiler to statically allocate threads, which should maintain the reproducibility of results. A more thorough approach to reproducible PRNGs would be to statically allocate threads.

A.6 Infection model

At the start of each day, various properties of the current state of the population is recorded, depending on the return type selected. In all cases, the number of active cases is recorded. If the number of active cases reaches zero, or the number of days to simulate is reached, the model terminates and these daily summaries are returned.

370. See Lemire (2020).

Each person has a **Status** which is a 32-bit signed integer indicating whether or not they are infected or have been infected, whether or not they are in isolation, and whether they are in intensive care. A status of zero indicates the person is susceptible to infection (but not in isolation). Negative values indicate the person had been infected previously. Individuals with negative statuses cannot be reinfected.

If an age-based lockdown is selected, the status of all individuals of the ages requested have their status flagged as isolated.

All infected individuals are then moved either from a communicable period to one of 'symptomatic' or 'critical', or from one of those status to 'healed' or 'killed', based on the precomputed prognosis.

Next, the person-to-person infection model runs, determined by the policy inputs and the epidemiological inputs. Each person can be infected at a supermarket, a 'place', a workplace, a school, at home, at a major event, or via a visitor from another SA2. Each day the order of these infectors is randomized, but the order on any day is the same for all individuals, except that household infection always occurs last. Following the modelling of household infection, contact tracing is performed, if requested, and isolation applies for the next day.

While the reinfection mechanism at each site is coded separately, this is mostly for performance or technical reasons.³⁷¹ All infection sites work in the same essential way. A person is **infectious** if the current day is between the date of infection and the end of the person's communicable period. Individuals do not infect others once their communicable period is over.

371. For some sites infections can be recorded on the stack, whereas for others this would overflow the stack. The default ordering of the data groups SA2s together, so some sites (like supermarkets and households) can use this assumption whereas others cannot.

A site can be visited or not visited by an infectious individual. If the site is infected, parameters prefixed with $a_$ determine whether this site acts as a site of infection or not. If the site is infectious, each susceptible visitor to the site is infected probabilistically via parameters prefixed with $q_$. Previously we also allowed $r_$ parameters, which acted as the reproduction number for each site. The disadvantage of this parameterization was that the number of new infections at a site would be independent of the number of visitors to the site, which would limit the ability of the model to handle policy changes which limited the size of gatherings, workplaces, and the like.

Even if a person is simulated to have come into contact with an infectious person at an infectious site, they may not become infected themselves if they are sufficiently resistant or if they have already been infected.

A.6.1 Supermarket infections

Supermarkets are used to model basic interactions among people in the same suburb. While supermarkets themselves have not been sites of known infections, they were used as a convenient tool for clustering individuals by their place of residence. For this reason, we allow more frequent visits to supermarkets than might be expected and allow the rate of transmission to be higher than might be expected from transmission from supermarkets alone.

Each person has a 'typical' supermarket drawn from the static data.

The frequency of an individual's visits to their typical supermarket is a random variable drawn from a beta distribution with user-visible shape parameters. By default, the distribution is skewed so that approximately 40% of individuals visit the supermarket 6 times a week or more.

Supermarkets have the same opening hours each weekday, but reduced opening hours on weekends. Each person visits at a fixed

hour, which is based on the modulus of the row numbers. The transmission probability is with respect to contact of people who visit the same supermarket in the same hour.

Infected individuals are not bound by caps on supermarket sizes, but susceptible individuals are. For a given supermarket-hour, individuals enter supermarket in the order they appear in the data, which exaggerates the effect of supermarket caps. On each day, each person is assigned a new `unsigned char`, which is a Bernoulli random variable with the user-supplied transmission probability.

A.6.2 Places

Infection of ‘places’³⁷² takes place in a manner similar to that of supermarket infections.

All persons above the age of 12 visit cafés n times per week where n is drawn from a uniform distribution $\{0, 1, \dots, 7\}$. An equal number of people visit once every day as once every week. All cafés are open for eight hours every day and, like supermarkets, contact with an infection person only occurs if the visit coincides in the same place-hour. With probability $1/8$ an individual visits a different café in their SA2 than their typical haunt.

A.6.3 Workplaces

A user-supplied parameter gives a probability that a given workplace can act as a site of reinfection. Unless the user requests a value of 100% – that all workplaces be potential sites – this is intended to reflect the potential that some workplaces are more conducive to reinfection, as well as some workplaces taking greater precautions than those required by the policy parameters.

³⁷². Currently, the only places are cafés.

In addition, a random variable is generated daily for each person determining for each day and each person the probability that that person will be infected, given an infected person attends their workplace. If a cap of the number of individuals is enforced via a policy parameter, infected individuals only attend work if the number of uninfected workers does not exceed the cap. Put another way, if a person is infectious but not symptomatic they are the first to remain home in the presence of a cap on the number of workers. While individuals who are totally asymptomatic may go into work as often as uninfected people, we assume that ‘asymptomatic’, in this context, means ‘less symptomatic’ or ‘lacking sufficiently obvious or severe symptoms to self-identify as symptomatic’. Hence, especially in the presence of an epidemic, are, despite the mildness of their symptoms, much less likely to attend work.

A.6.4 Schools

The modelling of reinfections through schools is very similar to that through workplaces. There are a few differences. First, schools have school terms and no infection is possible through schools outside school terms. Similarly, schools open only on school days (or on fewer days if set by policy).

Secondly, there is a dynamic element specific to schools. We assume that state governments are sensitive to outbreaks in schools. So, independently of contact tracing, school infections can trigger school lockdowns. If a (user-supplied) threshold of schools have at least a (user-supplied) number of infected students, the state’s school system is shut down for a (user-supplied) number of days. Independently, if any student’s illness becomes critical, the school system is shut down for a (possibly different) number of days. While the condition for triggering such lockdowns can occur on any school day, the lockdown is only enforced over the weekend or the following week.

A.6.5 Households

Infections through households are modelled very similarly to workplace infections, with both an atomic probability that a household will be infected and contact transmission probabilities for people in the same household. Policy parameters are limited for households.

A.6.6 Other SA2s

To model movement out of SA2s (though likely within the same state), we generate an exponentially distributed random variable with parameter $\beta = 1$ for each individual to represent the maximum allowable distance that person travels. If the distance is less than the distance to the nearest SA2, the person does not travel outside the SA2; otherwise, the SA2 is chosen through that distribution (close SA2s are more likely to be visited than those farther away). On each day, a person visits another SA2 with probability 1%. If an infected person does go to a different SA2, they visit a random individual in the SA2 and infect them (with certainty).³⁷³

A.6.7 Major events

For each individual we construct an integer, drawn from a beta distribution ranging from zero to the number of major events requested. The number of people assigned to each event so constructed is calculated and, if it exceeds the maximum number allowed, is ignored. Otherwise, the number of infected attendees is calculated. We then calculate, for each event, the value

$$p_e = q_m(1 + \sqrt{(n_i/N)})$$

373. The parameters $\beta = 1$, the independent probability of travelling outside an SA2, and the certainty of an infected visitor infecting someone were all chosen arbitrarily.

where q_m is a user-supplied parameter, n_i is the number of infected individuals, and N is the total number of attendees. This value inflates the threshold below which a person is infected or not. So the higher the proportion of infected individuals at a large event the more likely each susceptible attendee is to be infected.

A.7 Contact tracing

At the end of each day contact tracing is performed. The effect of contact tracing is that contacts of infected persons who would otherwise be susceptible individuals become isolated after successfully being traced.

Asymptomatic individuals have a 1% chance of seeking a test and 100% of symptomatic individuals seek a test. The algorithm goes through each infected individual, who is not in isolation. If the individual has already been tested and the test result was positive, the individual is not retested. If the previous test result was a (false) negative, the person has a 1/32 chance of being retested on any day while infected. An infected person has a 38% chance of a false negative that is independently generated each day for each person.³⁷⁴

For each state, and for Australia overall, the number of tests so performed are counted. If for a particular state, or Australia overall, the number of tests exceed the user-supplied cap on the number of tests, a random fraction of the tested individuals are 'untested' so as to lower the count to below the cap. For the remaining tested individuals the `InfectedOn` column records the date of their test, and is signed by the test outcome (positive or negative).

Two parameters affect the delay between showing symptoms of the disease and the day on which contact tracing has effect:

374. See Kucirka et al (2020) for estimates of the false negative rate. The 95% credible interval was for the false negative rate was 18% to 65% (at the onset of symptoms).

days_before_test and days_to_notify. These are set relative to the end of each individual's communicable period. Contact tracing can be successful or not, depending on a user-supplied probability of success. If contact tracing is modelled to succeed for a particular positive test recipient, contact tracing is performed on the following individuals. If the person is a member of a multiperson household, all members are isolated. If the person is a school pupil, all pupils at that school of the same age are also isolated. (Isolation is permanent.)

A.8 Epidemiological characteristics of COVID-19

A person who is exposed to COVID-19 and becomes infected takes time to develop symptoms during their incubation period. As the virus builds up, they can start to show symptoms and become ill.³⁷⁵ A person with COVID-19 can be infectious before they develop symptoms and while they are symptomatic.

The type of interactions they have with others – indoors or outdoors, with physical contact or not, for a long time or short – will affect the number of people they infect, as will the number of such interactions.

These factors determine the spread of COVID-19 within the population. Our understanding of these factors and their effect on the spread of COVID-19 is explored in this section.

A.8.1 Viral load, viral shedding, and the infectious dose

As COVID-19 builds up in a person's body, their viral load – how much of the virus they have in their body – rises.³⁷⁶

As this viral load builds up, people start to 'shed' the virus by expelling small particles through coughing, sneezing, and speaking.³⁷⁷ These

viral particles can be passed from person to person directly, called 'droplet transmission', or can attach themselves to a surface to be picked up later, called 'contact transmission'.³⁷⁸

Aerosol transmission – where the small droplets evaporate before they fall to the ground, leaving the dried-out virus to drift freely through the air³⁷⁹ – is not yet recognised as a source of transmission by the WHO. But evidence to date suggests it is likely.³⁸⁰ Aerosol transmission was confirmed for SARS-CoV-1, allowing the spread of disease over longer distances.³⁸¹ An aerosol of the SARS-CoV-2 virus has been observed in lab settings³⁸² and in hospitals in Wuhan.³⁸³ This has consequences for precautions and restrictions: keeping 1.5 metres apart isn't effective if the virus can, and does, travel further.³⁸⁴

The average number of these particles needed to start an infection in another person is called the infectious dose.³⁸⁵ The higher the infectious dose, the less likely a disease is to spread.³⁸⁶ The infectious dose for COVID-19 is not yet known.

For the virus to spread, a person carrying it must build up a viral load. They then must shed viral particles that are picked up by another person, and the number of particles picked up must be greater than the infectious dose required for the virus to take.

375. World Health Organisation (2020n).

376. Ball (2020). The viral load is highest during the first week after the onset of symptoms: To et al (2020).

377. World Health Organisation (2020h).

378. World Health Organisation (2020c). The virus can remain viable on most surfaces for hours: Bar-On et al (2020); and on stainless steel and plastic for longer than three days: Doremalen et al (2020).

379. Couch et al (1966, p. 517).

380. Morawska and Cao (2020); and Fineberg et al (2020, pp. 19, 35–37).

381. Li et al (2005); and Booth et al (2005).

382. Doremalen et al (2020).

383. Liu et al (2020b).

384. World Health Organisation (2020c). See also Yong (2020) for a discussion.

385. See Geddes (2020).

386. The infectious dose for COVID-19 is currently unknown but estimated to be low given it is very contagious: Geddes (ibid).

A person's viral load builds up before they show symptoms, meaning they can start to shed the virus before they show symptoms. There is evidence of this pre-symptomatic transmission one-to-three days before symptom onset.³⁸⁷ This poses a particular problem: people without symptoms – and so who don't see a reason to self-isolate – spreading the virus.

Some people pass through the illness period showing few symptoms or none at all (see Appendix A.9). But these people can still spread the disease.³⁸⁸

A.8.2 The infectious and incubation periods

The time between becoming infected with the virus and developing symptoms is known as the incubation period (see Figure 3.1 on page 39).

The incubation period affects the speed of COVID-19 transmission from one person to the next. A longer incubation period means a longer time between a person becoming infected and realising they are infected. It is a key factor in determining quarantine lengths for people who may have been exposed to the virus, such as those with an infected housemate, or people coming from overseas.

Using patient interviews and contact tracing, researchers from around the world have estimated the incubation period of thousands of COVID-19 patients. Figure A.3 shows the results from such studies.

Early studies from Wuhan observed incubation periods averaging about 6 days, with 95 per cent of people having an incubation period between 3 and 11 days.³⁸⁹ This range was supported by subsequent studies

387. He et al (2020); Arons et al (2020); Nishiura et al (2020); Tindale et al (2020); and Tong et al (2020).

388. Emery et al (2020).

389. Backer et al (2020); and Lauer et al (2020).

from around China in Shanghai,³⁹⁰ Zhejiang,³⁹¹ Shenzhen,³⁹² and Beijing.³⁹³ Similar results for incubation periods were found in countries that were affected early, such as South Korea.³⁹⁴

While some studies have shown a slightly longer average incubation period – between 7 and 9 days – meta-analysis of the literature suggests the true average is about 6, with a log-normal distribution.³⁹⁵

As shown in Figure A.3, some individuals have been observed with much longer incubation periods of 20 or 30 days.³⁹⁶ But the vast majority – about 99 per cent – have incubation periods less than 15 days.³⁹⁷

Individuals are also infectious for different durations. Information about the virus to date suggests the average duration is about 8-to-10 days.³⁹⁸ But, as with the incubation period, some people are infectious for much longer.³⁹⁹ Table A.2 shows the distribution of infectivity used in our modelling.

A.8.3 How many others does a person infect?

A disease's basic reproduction number – its R_0 – is the number of additional people each case infects, on average, with a fully susceptible population and no controls in place.⁴⁰⁰ It is a useful statistic, but hides important facts about the spread of disease.⁴⁰¹ In reality, the distribution

390. Lu et al (2020).

391. Qian et al (2020).

392. Bi et al (2020).

393. Tian et al (2020).

394. Kong et al (2020).

395. McAloon et al (2020).

396. C. Qiu et al (2020).

397. Bar-On et al (2020).

398. Housen et al (2020); and To et al (2020).

399. To et al (2020).

400. See Box 1 in Chapter 1.

401. Rossman (2020).

of individuals' infectiousness is highly skewed: some people will pass the virus on to nobody else, while others will pass it on to 10 people or more.⁴⁰²

Examples of this were seen in early analysis of COVID-19 clusters in China, shown in Figure 3.2 on page 41.⁴⁰³ During a dinner in late January, one COVID-19 case infected the other eight people. During a large gathering, a single person infected 10 others.

The skewed distribution of infectiousness isn't unique to COVID-19. It is a common feature of infectious diseases, including the measles, smallpox, SARS,⁴⁰⁴ and MERS.⁴⁰⁵

While research is evolving in this area, early analysis suggests that about 10 per cent of people are responsible for 80 per cent of COVID-19 spread.⁴⁰⁶

The goal of COVID-19 policies is to decrease the exposure of susceptible people to infected individuals,⁴⁰⁷ and policy makers can exploit the fact that the virus is mostly passed on by highly infectious people at super-spreading events.⁴⁰⁸ This means shutting down high-risk events – removing the opportunity to have super-spreader events – can be highly effective. These policy decisions are discussed in Chapter 3.

402. Lloyd-Smith et al (2005).

403. Liu et al (2020b). Using these clusters, the authors concluded that the secondary attack rate was between 27 and 44 per cent. However, this was an early study and the authors acknowledged the need for further research.

404. Lloyd-Smith et al (2005).

405. Kucharski and Althaus (2015).

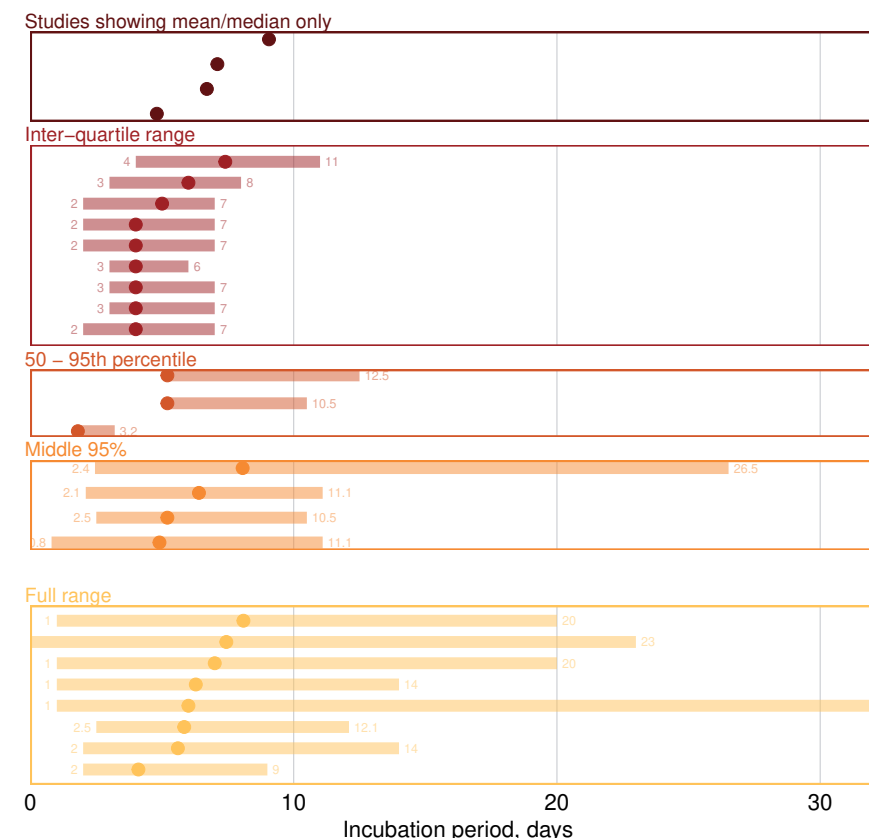
406. Endo et al (2020).

407. Bourouiba (2020).

408. Kupferschmidt (2020).

Figure A.3: Incubation period

Observed COVID-19 incubation periods in studies since February



A.8.4 Likelihood of becoming infected when exposed to the virus

The likelihood that a person will become infected when exposed to COVID-19 is called the 'secondary attack rate'.⁴⁰⁹ A higher secondary attack rate means the virus spreads to more people, and passes through the population more quickly.

Specific settings can pose greater risks of infection than others for COVID-19. These are settings that increase the likelihood of an infectious dose being passed from one person to another, like being indoors, sharing meals, or singing.⁴¹⁰

Knowing the secondary attack rate in the home is important in understanding the spread of COVID-19. Analysis of 391 clusters and their 1,286 contacts in Shenzhen, China,⁴¹¹ found that about 10 per cent of contacts in the home became infected. In a smaller study of 195 unrelated clusters from Guangzhou, researchers determined a household secondary attack rate of 19 per cent.⁴¹²

A.9 COVID-19 patient outcomes

A.9.1 Asymptomatic cases

Being asymptomatic means a person doesn't feel ill. But what is good for the individual can be detrimental to the group: they can spread the virus without knowing they have it.⁴¹³

The true proportion of people who do not show symptoms is not well understood. Under symptom-based testing – such as has been the policy in Australia until recently – asymptomatic cases are unlikely to

be tested and diagnosed. Symptom-based testing tells us how many symptomatic people tested positive for COVID-19, rather than how many people *have* COVID-19. Tests are mostly done on people who appear sick, and asymptomatic people, by definition, do not appear sick.

To determine asymptomatic COVID-19 rates, people without symptoms need to be tested.⁴¹⁴ This happens in two scenarios: when all close contacts of a confirmed case are tested, and when a random sample of people is tested.

A random sample of the population was tested in Iceland. Among people who tested positive for COVID-19, about 40 per cent reported having no symptoms.⁴¹⁵ However, the authors of this study note that symptoms 'almost certainly' developed after testing for some, so the true asymptomatic rate is likely to be lower.

A study of COVID-19 cases and their contacts found that about 20 per cent of cases were asymptomatic at the time of their positive test result.⁴¹⁶

Analysis of the people on the Diamond Princess – a cruise ship with an early outbreak of COVID-19 – showed a higher rate of asymptomatic cases. About three-quarters of confirmed cases were asymptomatic.⁴¹⁷ An assessment of another cruise-ship outbreak in South America found similar asymptomatic rates.⁴¹⁸ However, these high asymptomatic rates are likely overstated, with some pre-symptomatic people being incorrectly classified.⁴¹⁹

409. Centers for Disease Control and Prevention (2020a).

410. Read (2020).

411. Bi et al (2020).

412. Jing et al (2020).

413. Ma et al (2020).

414. COVID-19 can also cause minor cold-like symptoms, increasing the difficulty of detecting the virus: Woelfel et al (2020).

415. Gudbjartsson et al (2020).

416. Bi et al (2020).

417. Emery et al (2020).

418. Ing et al (2020).

419. Lewin (2020).

A.9.2 Hospital and ICU rates

Some of the people who get sick will need care at a hospital, and a minority of those will require care in an ICU.

In its modelling for the Australian Government, the Doherty Institute provided estimates of hospitalisation and ICU rates, shown in Table A.1.⁴²⁰ The severity of illness from COVID-19 is closely related to age, with older people suffering worse outcomes than younger people. The hospitalisation risk is almost zero for children, while 10-to-20 per cent of octogenarians will require an ICU bed.

The expected use of hospitals and ICU facilities determines our healthcare system's capacity to cope with the COVID-19 pandemic.⁴²¹

A.9.3 Death

Understanding the mortality from COVID-19 is crucial in understanding the risk it poses to society. Two statistics are used to inform our understanding of the mortality danger of COVID-19.

The case fatality rate

The case fatality rate (CFR) is the 'ratio of the number of deaths divided by the number of confirmed cases of disease'.⁴²² This makes it a relatively simple number to calculate: take the number of people who have died from the disease and divide it by the number of cases.

By late May in Australia, for instance, there had been 100 deaths from 7,081 cases, meaning the CFR was 1.4 per cent.⁴²³

420. Moss et al (2020, table 2). See also Verity et al (2020, table 3).

421. Duckett and Mackey (2020d); and Duckett et al (2020).

422. Condit (2020).

423. Department of Health (2020h). See also Collignon and Beggs (2020, table 1).

Table A.1: Hospitalisation and ICU rates by age

Age group	Hospitalisation rate, %	ICU rate, %
0 – 9	0.03 – 0.06	0.01 – 0.02
10 – 19	0.03 – 0.06	0.01 – 0.02
20 – 29	0.39 – 0.78	0.11 – 0.23
30 – 39	1.45 – 2.90	0.43 – 0.85
40 – 49	2.55 – 5.11	0.75 – 1.50
50 – 59	4.95 – 9.90	1.45 – 2.91
60 – 69	7.75 – 15.49	2.27 – 4.55
70 – 79	17.88 – 35.76	5.25 – 10.50
80+	32.97 – 65.94	9.68 – 19.36

Source: Moss et al (2020, table 2).

Researchers looking at 43,000 cases in China concluded that the CFR was 1.38 per cent, similar to that in Australia.⁴²⁴ They found that the case fatality rate, like demand for hospital and ICU beds, increased substantially with age.

While the CFR can provide a broad understanding of the mortality risk from COVID-19, it doesn't tell us exactly how dangerous the disease is. It misses some people: those who became infected but did not get tested, or did not have their test recorded. The CFR is therefore heavily influenced by the level of testing.

However, what we know about the CFR of COVID-19 shows that the risks are far higher for older people.

People aged 80 and have a CFR of about 15 per cent – 150 times higher than for people aged between 20 and 50. There are very few deaths among people aged below 20 years of age. Higher case fatality rates for older people are likely to be affected by underlying health conditions. In China, fewer than 1 per cent of people with no underlying

424. Verity et al (2020, table 1).

health conditions died when they contracted of COVID-19, compared to 10 per cent of people with underlying cardiovascular disease.⁴²⁵

Long-term residential-care facilities for older people are particularly likely to increase the case fatality risk. Between 30 and 50 per cent of all COVID-19 deaths in Europe, the US and Australia have been residents of long-term residential-care facilities.⁴²⁶ Most residents are older and have underlying health problems, and the conditions of long-term care facilities are likely to promote the spread of infection.

The infection fatality rate

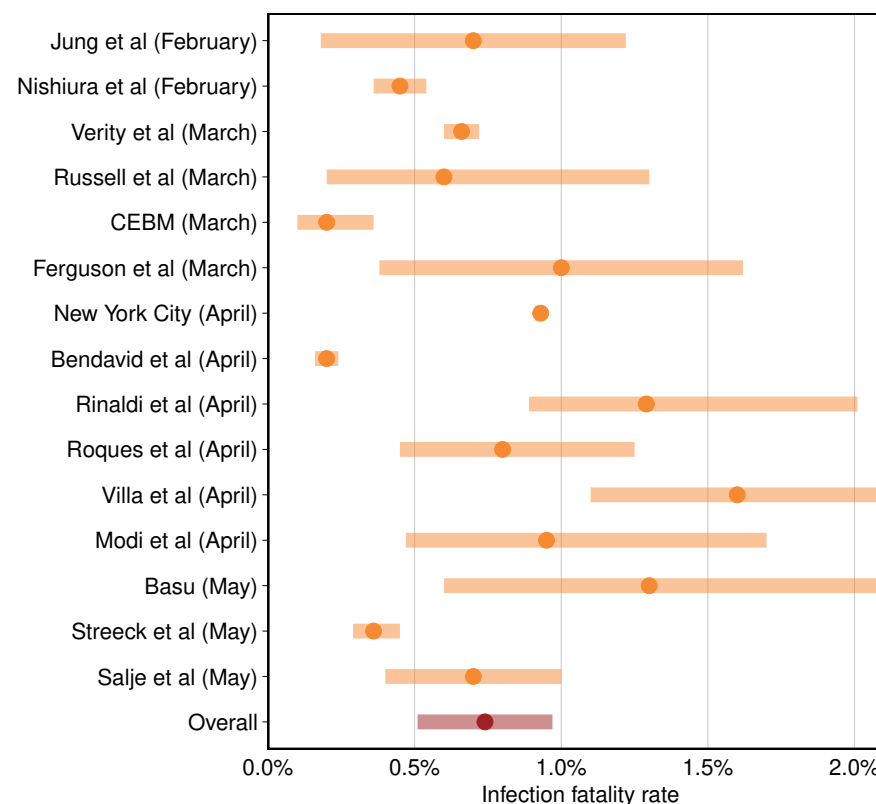
The infection fatality rate (IFR) is the number of deaths divided by the actual number of infections from a disease. This statistic includes all people who were exposed and became infected, not just those who had their case recorded.

The benefit of the IFR is that it provides a clearer picture of mortality risk. An IFR of 1 per cent means that 1 per cent of people who become infected ultimately die, and so the risk of dying if you get the disease is 1 per cent.⁴²⁷

But the IFR is more difficult to determine than the CFR because it requires knowing the actual number of infections in a population. This requires serology testing of SARS-CoV-2 antibodies (Appendix A.8.2).

Figure A.4 shows that current IFR estimates for COVID-19 suggest the rate is between 0.5 and 1 per cent, about 5-to-10 times higher than seasonal influenza.

Figure A.4: Meta-analysis of COVID-19 infection fatality rates



Source: Meyerowitz-Katz and Merone (2020, figure 2.).

425. Our World in Data (2020b).

426. European Centre for Disease Prevention and Control (2020); and Kaiser Family Foundation (2020).

427. On average.

A.10 COVID-19 and children

The understanding of COVID-19 described above is further complicated by the fact that there is still a lot we don't know about how the virus affects children.⁴²⁸

A.10.1 How easily do children catch COVID-19

Children of all ages can get COVID-19.⁴²⁹ There have been about three hundred confirmed cases of children with COVID-19 in Australia so far.⁴³⁰

Evidence so far suggests many children with COVID-19 are symptom-free,⁴³¹ meaning that testing of just symptomatic patients – as was the conditions for testing in Australia until May – will miss infected children. Broad testing is needed to identify the children with the virus.

In Iceland, 10,800 asymptomatic people were tested for COVID-19 in mid-to-late March. About 0.8 per cent were positive.⁴³² Of the 848 children under 10 years of age, none had the virus; of the 1200 children aged 10-19, 0.4 per cent tested positive – half the rate of the adults.

A study of 195 clusters in Guangzhou concluded that children were less likely to become infected than adults.⁴³³ In Hunan, contacts of COVID-19 patients were placed under medical observation for 14 days and analysis of their outcomes also found lower risk of infection for children.⁴³⁴

428. See also Duckett and Mackey (2020b).

429. Here, we mean children 18-years-old and younger. The studies discussed in this section use different age ranges to define 'children'.

430. O'Brien et al (2020).

431. Kelvin and Halperin (2020); H. Qiu et al (2020); and Boast et al (2020).

432. Gudbjartsson et al (2020).

433. Jing et al (2020).

434. Zhang et al (2020).

However, in Shenzhen, a study of 391 cases and 1,286 of their close contacts found that children were 'just as likely' to contract the virus as adults under 50.⁴³⁵ But the balance of evidence so far suggests that children – especially children younger than 10 – are less likely to pick up the virus.⁴³⁶

A.10.2 How easily do children spread COVID-19

Children can pass on COVID-19 to adults and other children. But observational evidence so far has shown that they are less likely to spread the virus than adults. The World Health Organisation's chief scientist Soumya Swaminathan has acknowledged that children 'seem less capable of spreading the virus' than adults.⁴³⁷

At the beginning of the COVID-19 epidemic in Australia, the National Centre for Immunisation Research and Surveillance (NCIRS) studied 9 adult and 9 child cases of COVID-19 in 15 NSW schools.⁴³⁸ The study identified 832 'close contacts', 735 of them children. One-third of this group were interviewed, tested with nasal swabs 5-to-10 days after contact, and had a blood sample examined for antibodies one month later.

One child in primary school tested positive on both the nasal swabs and for antibodies; and one child in high school tested positive for antibodies, but not on the initial nasal swab.

These cases happened in early March, before governments started imposing lockdowns or even recommending social distancing. Back then, Australia had done little to reduce the spread of COVID-19. That two children out of 288 tested positive indicates that child-to-child

435. Bi et al (2020).

436. Boast et al (2020); and Somekh et al (2020).

437. Swaminathan (2020).

438. National Centre for Immunisation Research and Surveillance and NSW Health (2020).

transmission is possible, but it also suggests that the rate of transmission is low.

The NSW study is in line with other observational studies. A study of an outbreak in the French Alps found that a symptomatic child had visited and had 'close interactions' in three schools without passing on the virus to anyone.⁴³⁹ The authors said this suggested 'different transmission dynamics in children'.

A multinational study of 33 household clusters found that a child under 18 was the initiating contact ('index case') for three.⁴⁴⁰ The authors note that this is well below otherwise similar infections such as the H5N1 influenza virus, in which children are the index case about half the time.

In the Netherlands, the Ministry of Health studied 54 households with COVID-19 infections and found that while children did become infected, they were never the source of the spread.⁴⁴¹

A.10.3 How does COVID-19 affect children?

We know that children with COVID-19 can become severely ill. But the available evidence strongly suggests they become severely ill at lower rates than adults.

A comprehensive study of 2,135 paediatric cases in China found more than half had mild (flu-like) symptoms at worst.⁴⁴² About 40 per cent had moderate symptoms, such as pneumonia, frequent fever, and dry cough. The remaining 5 per cent were classified as severe or critical, compared to 19 per cent of adults in China at the same time.

439. Danis et al (2020).

440. Zhu et al (2020).

441. National Institute for Public Health and the Environment (2020).

442. Dong et al (2020) The number of asymptomatic cases is likely to be under-reported due to missed diagnoses.

Severe illness from COVID-19 in children is rare.⁴⁴³ There have been cases of a serious hyper-inflammatory syndrome may be connected to COVID-19, and has been documented in Italy, France, the UK and the US.⁴⁴⁴

Similarly, children can and do die from COVID-19.⁴⁴⁵ There have been deaths of children in China,⁴⁴⁶ the US,⁴⁴⁷ the UK,⁴⁴⁸ France,⁴⁴⁹ and other countries with substantial outbreaks. But this outcome remains extremely rare.⁴⁵⁰

A.11 Using known epidemiological characteristics of COVID-19 to model its spread

The information about COVID-19 has led us to use the following default parameters in our modelling, shown in Table A.2 on the following page.

Table A.3 shows the policy settings the model can explore, and their default values.

A.11.1 The number of active cases in the community is not known

COVID-19 spreads through an infected person to a susceptible person. To understand how it spread in the past, the number of infected people in the community needs to be known.

443. Ibid.

444. Boast et al (2020). This syndrome resembles Kawasaki shock – a rare disease in young children – that has been linked to earlier coronaviruses: Esper et al (2005) and L. Chang et al (2006). But with few cases worldwide, its relationship to COVID-19 is still an area of developing research: Burgner et al (2020).

445. Ludvigsson (2020).

446. Dong et al (2020).

447. Centers for Disease Control and Prevention (2020b).

448. Public Health England (2020).

449. Thiebaut and Lafaurie (2020).

450. Ludvigsson (2020); and Boast et al (2020).

In the Australian context, this number is unknowable for three reasons. First, how long each COVID-19 case is infectious for is unknown. In most states, interviews are conducted in the weeks after a positive test result to determine whether a person is still infectious.⁴⁵¹ The national guidelines state that this must be at least 10 days since the positive test and after at least three days without symptoms.⁴⁵² But there is variation in how and when states record and report recovered, and therefore active, cases of COVID-19. Figure A.5 shows states reporting of active cases compared to imputed active cases assuming an illness duration of about 15 days.⁴⁵³

Second, there are cases of COVID-19 that go unrecognised and untested, and are therefore unrecorded. This is particularly true for people with little or no symptoms, who carry and can spread the virus, but may not know they have it.

Third, a large proportion of Australia's COVID-19 cases came from overseas. From March 27, overseas arrivals have been quarantined for two weeks in hotels, meaning they are not in the community spreading the virus. But before March 27 they were asked to self-isolate in their homes. Exactly how many adhered to that policy, and how strictly they followed it, can't be determined.

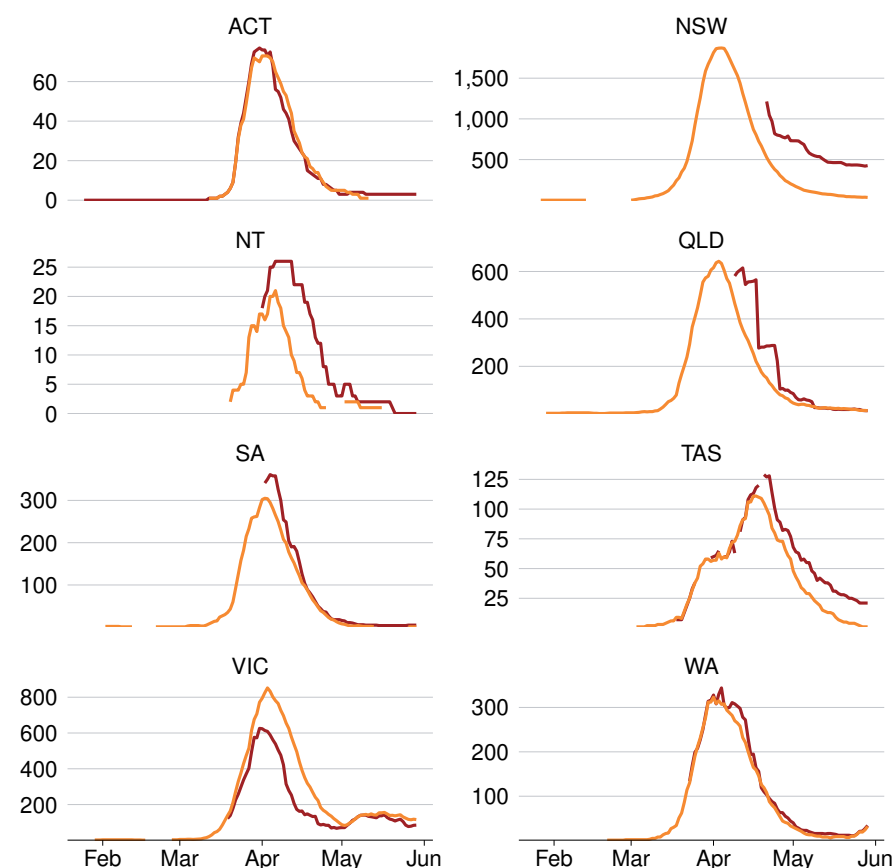
To address these three issues and to roughly match state and territory reporting, we model active cases in the community by using data

451. Inquiries by O'Brien et al (2020) found that officials from ACT Health, Queensland Health, SA Health and WA Health interview patients after a positive test and assess them according to the national guidelines. Officials at NSW Health interview people three weeks after a positive test and record whether they have recovered: NSW Health (2020). Departments of Health in Victoria and Tasmania have not made public how they assess patient recoveries: O'Brien et al (ibid).

452. Communicable Diseases Network Australia and Department of Health (2020, p. 16).

453. Each new case is given an illness duration that is drawn from a Poisson distribution with mean 15.

Figure A.5: Imputed active cases
Number of active cases by state, **imputed** and **reported**



from April onwards; excluding overseas arrivals; and assuming that a person's illness duration is Poisson distributed around 15.

A.11.2 Comparing simulation results with active cases

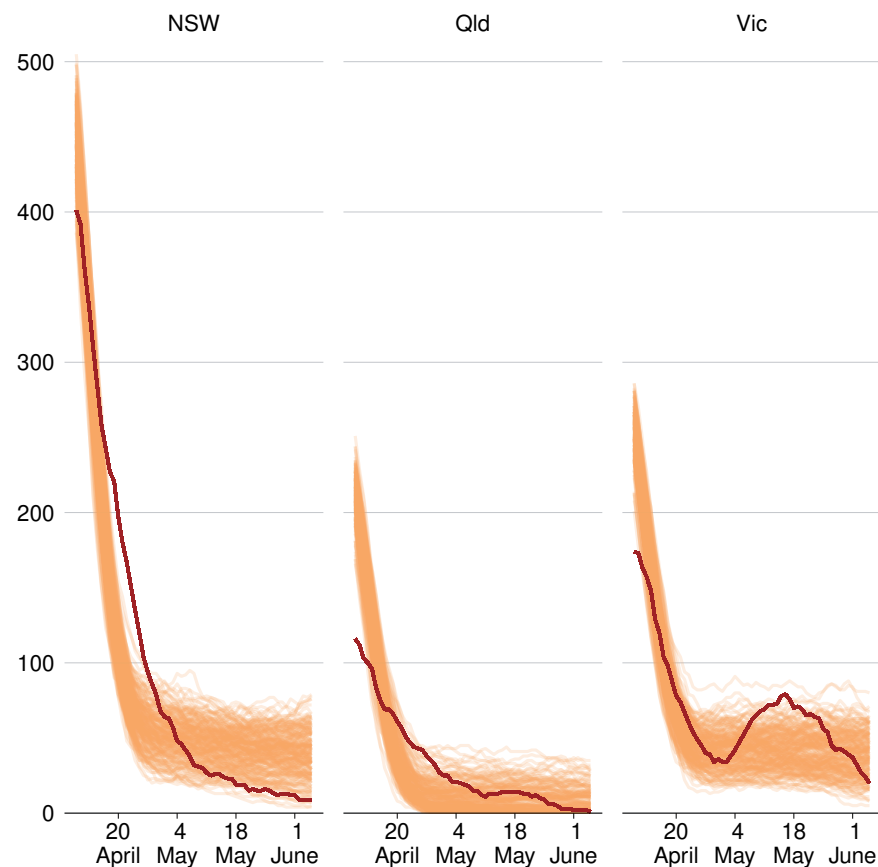
Figure A.6 shows local active cases in NSW, Queensland and Victoria against 200 simulation runs using the default parameters in Table A.2 and Table A.3.

Each simulation is shown as an orange line and represents a plausible path of active local COVID-19 cases in each of the states. With the epidemiological settings and the actual policy settings, the simulated results map relatively closely to the sharp decline in active cases seen in each of the states. The reduction, but not a complete stop, to new cases means the virus has lingered. Each of the states have maintained a low number of active cases from late April until the start of June.

The information about COVID-19 described above led us to use the following default epidemiological parameters in our modelling.⁴⁵⁴

Figure A.6: Comparing Grattan's COVID-19 model with actual cases April-June

Active cases from **simulation runs** against **local active cases**



Source: Grattan analysis.

454. These parameters can be changed. See full model at Parsonage and Mackey (2020).

Table A.2: Base epidemiology settings

Parameter	Default	Comment
Communicable period distribution	Poisson	
Communicable period mean	8 days	
Illness distribution	Poisson	
Illness mean	15 days	
a_workplace_rate	80%	Proportion of workplaces that can facilitate virus spread
a_household_rate	100%	Proportion of households that can facilitate virus spread
a_schools_rate	100%	Proportion of schools that can facilitate virus spread
q_workplace	1/10	Transmission probability: the chance that an individual may be infected, given the individual attends a workplace with an infected individual on the same day as the infected individual attends work
q_household	1/20	Transmission probability (as above) for households
q_school	1/5000	Transmission probability (as above) for schools
q_supermarkets	1/1000	Transmission probability (as above) for shops
q_places	1/100	Transmission probability (as above) for shops
resistance_threshold	Decreasing linearly from 85% for 0-year-olds to 40% for 100-year-olds	The number of people out of 1000 who are naturally resistant to the virus
p_asympto	35%	The proportion of cases that do not develop symptoms
p_critical	1.7/4.5/7.4%	The proportion of symptomatic cases that become critical, ages 0-49/50-64/65+
p_death	2.94/4.44/17.57%	The proportion of critical cases that die, ages 0-49/50-64/65+
supermarket_beta_shape1,2	3, 1	Parameters to the beta distribution that govern how frequently individual visits a supermarket

Table A.3: Base policy settings

Parameter	Default	Comment
supermarkets_open	TRUE	Should shops remain open?
schools_open	TRUE	Should schools remain open?
only_Year12	FALSE	If schools open, should they be restricted to Year 12 students only? No effect if schools_open = FALSE.
school_days_per_wk	5	Specifies how many days a week pupils attend school.
do_contact_tracing	TRUE	Should contact tracing occur? If FALSE households are not isolated if tested.
contact_tracing_days_before_test	1	The number of days after the end of the incubation period before the person gets tested.
contact_tracing_days_until_result	2	The number of days between a test and the result being known.
contact_tracing_only_sympto	FALSE	Is contact tracing only applied to symptomatic cases?
contact_tracing_success	70%	The proportion of contacts successfully traced.
tests_by_state	Inf	The number of tests per day that states can perform.
max_persons_per_supermarket	50	Maximum number of people allowed in a shop at the same time (within one hour i.e. concurrently).
age_based_lockdown	'None'	The ages (0-100) or a length-101 vector specifying the ages to be lockdown (as 1).
workplaces_open	70%	Proportion of workplaces that remain open.
workplace_size_max	30	The maximum size of any workplace. All people in a workplace will interact in a day.
workplace_size_beta, _lmu, _lsi	13, -1, -1	Parameters for the distribution of workplace sizes. _beta is the rate distribution for the geometric distribution; _lmu and '_lsi are the parameters for the lognormal distribution.
travel_outside_sa2	TRUE	Whether people travel outside their SA2. If TRUE, then 1% of people travel outside their SA2 and can infect while outside.

Appendix B: Simulation outcomes by state

This appendix presents three charts shown in Chapter 3 by states that had active COVID-19 cases on 1 June, 2020: New South Wales, Victoria and Queensland.

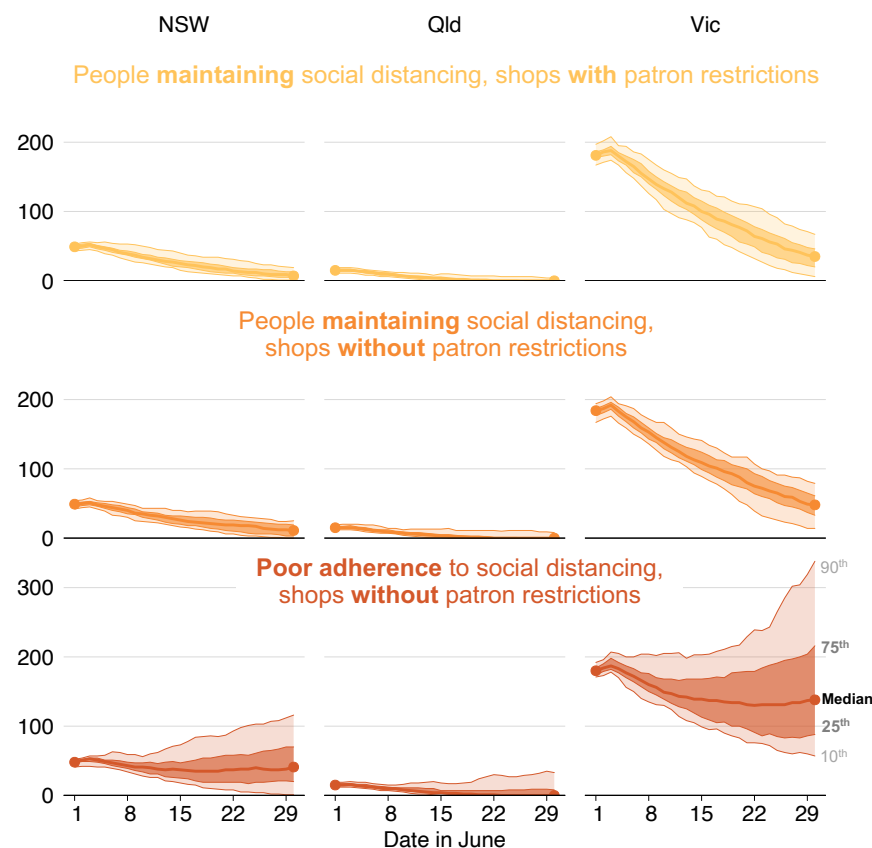
These charts demonstrate the importance of the number of active cases in the community before coming out of lockdown. Poor adherence to social distancing (discussed in Section 3.3), shown in Figure B.1, leads to more scenarios in which outbreaks occur and case numbers grow in Victoria and New South Wales. But Queensland, with few active cases remaining, is less likely to see an explosion of new COVID-19 cases.

Figure B.2 shows the risks of returning to normal in the workplace (see Section 3.4). The risk of outbreaks is still substantial in Victoria and New South Wales.

As children are less likely to catch and pass on the virus (see Section 3.5), schools are less likely to lead to significantly increased case numbers, shown in Figure B.3.

Coming out of lockdown remains a risk in states that have not yet effectively eliminated the virus.

Figure B.1: Social distancing efforts, by state
Results from simulation of active local COVID-19 cases

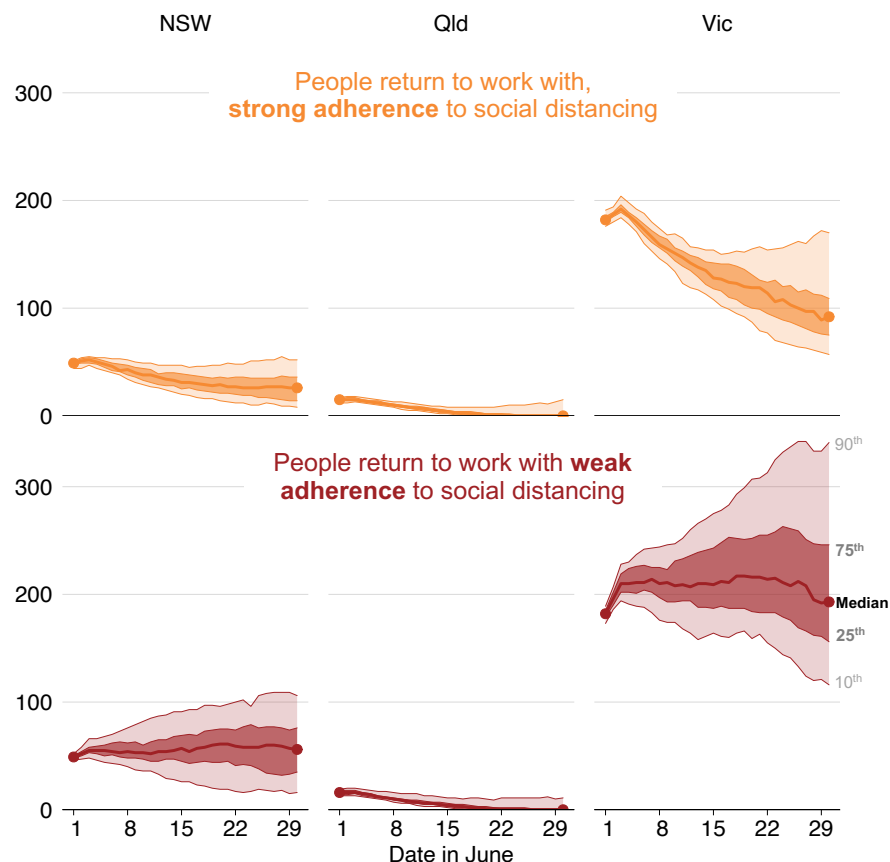


Notes: Grattan's COVID-19 microsimulation model. See discussion at Figure 3.5. The simulations use the settings provided in Table A.2 and Table A.3 with the following adjustments:

	Left panel	Middle panel	Right panel
Patron limit in shops	5	30	30
Secondary attack rate in shops	0.25%	0.25%	1%

Figure B.2: Reopening workplaces, by state

Results from simulation of active local COVID-19 cases

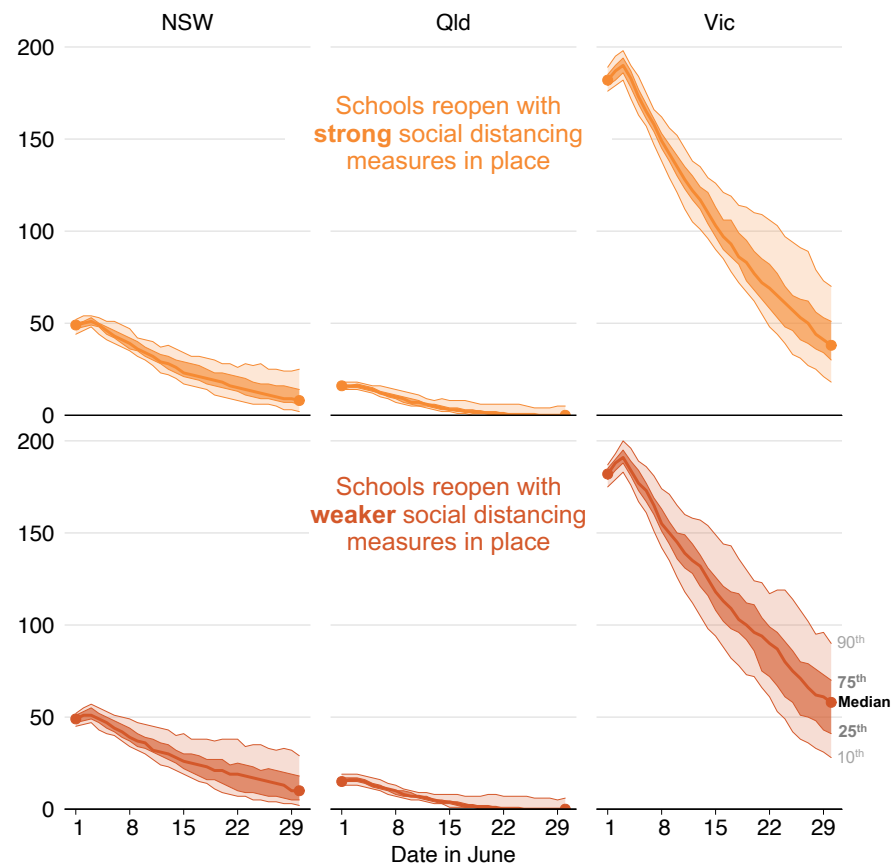


Notes: Grattan's COVID-19 microsimulation model. See discussion at Figure 3.6. The simulations use the settings provided in Table A.2 and Table A.3 with the following adjustments:

	Left panel	Right panel
Proportion of workplaces open	90%	100%
Max number of people allowed in workplace	200	200
Secondary attack rate at workplaces	0.05	0.15

Figure B.3: Opening schools, by state

Results from simulation of active local COVID-19 cases



Notes: Grattan's COVID-19 microsimulation model. See discussion at Figure 3.7. The simulations use the settings provided in Table A.2 and Table A.3 with the following adjustments:

	Left panel	Right panel
Secondary attack rate same school	1 in 100	1 in 5000

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