

CLINICAL PERSPECTIVES

COVID-19 and future pandemics: is isolation and social distancing the new norm?

Peter Collignon ^{1,2}¹Microbiology and Infectious Disease, Canberra Hospital, and ²Medical School, Australian National University, Canberra, Australian Capital Territory, Australia**Key words**

aerosols, COVID-19, droplets, infection control and prevention, public health, SARS-CoV-2.

CorrespondencePeter Collignon, Canberra Hospital, PO Box 11, Woden, ACT 2606, Australia.
Email: peter.collignon@act.gov.auReceived 2 November 2020; accepted
1 March 2021.**Abstract**

The coronavirus, named SARS-CoV-2, is the cause of COVID-19. This virus spreads readily from person to person and predominantly to and from the respiratory route and through droplets. There are many different interventions that can be and are used to decrease successfully the risk and spread of COVID-19. Most of the principles underpinning these interventions relate to isolation and social distancing. These will need to be continued, at least in part, until safe and very effective vaccines become widely available and are delivered extensively and successfully globally. This new norm is isolation, plus social and physical distancing, and this new norm will likely be with us for some time to come. It will also be with us in any future pandemics, whether caused by bacteria or viruses, but especially when the causative pathogen spreads predominantly through the respiratory route. However, lockdowns and restrictions also cause many adverse but unintended economic, social and health consequences. Therefore, what is put into place needs to be proportionate to levels of risk of disease as well as spread, and which will vary in different localities and with time.

Introduction

COVID-19 is caused by a coronavirus (SARS-CoV-2), which spreads readily from person to person. The virus has now spread widely around the world and did so within a few months of being first reported in China.^{1,2} However, it was likely circulating in people in Wuhan for some time before then, as already in December 2019 there were over a dozen strains of the virus.³ While COVID-19 was not identified to be in high numbers of people in North America and in Europe until February/March 2020, it was likely present a couple of months earlier and during their winters, when spread occurs more readily. In France, a man who was ill in late December 2019 was retrospectively identified to have had a severe COVID-19 illness. This implies, given the average incubation period for COVID-19 and additionally the time usually taken to develop severe symptoms leading to hospital admission, that the virus was

present in Paris since at least mid-December 2019.⁴ In the USA, it was also likely already present in December 2019.⁵

COVID-19 infections are associated with much higher mortality rates than all other common respiratory viruses, such as influenza.⁶ However, the COVID-19 case fatality rates reported globally are very variable.^{7–9} In Australia during our first wave, it was lower than in most other countries, but as elsewhere, very age dependent. In those over the age of 80 years, the case fatality rates are more than 10%, but in those aged <40 years, less than 0.1%.⁸ When global infection fatality estimates are estimated based on total cases and using serology, then overall fatality estimates are lower (0.68%).⁷ They range from 0.068% in those aged 35–45 years, but are hundreds of times higher, at 28.3%, in those over 85 years.⁹

Spread is predominantly by droplets

The SARS-CoV-2 virus is present in respiratory secretions and in faeces. It can also be found on surfaces after these have had respiratory secretions deposited on them.

Funding: None.

Conflict of interest: None.

Therefore, the virus can spread through direct contact with respiratory secretions, faecal material or from innate surfaces (through hands and then inoculation of eyes, nose or mouth). Close and prolonged contact indoors is the most important factor involved in the transmission of COVID-19, for example, within a household or workplace.^{10–13} Higher risk activities are being in air-conditioned or heated rooms with low humidity.^{14,15}

While the SARS-CoV-2 virus is present in faeces, the respiratory route seems to be the overwhelming way COVID-19 is transmitted. All major authorities (e.g. Centers for Disease Control and Prevention (CDC) in the USA, the World Health Organization (WHO) in Geneva and the Health Department of the Australian Government) have the view that current epidemiological evidence suggests that most transmission of COVID-19 in the community is through the air, but this transmission is mainly by droplets rather than by aerosols (the latter are much smaller than droplets and can stay suspended in air for many hours and travel much further).^{10–14}

Droplets are usually defined as particles of relatively larger size (more than 5–10 µm in size) and produced in large numbers when people cough or sneeze.^{10–16} However, they are also produced when people speak, sing or shout. They are called droplets because they usually ‘drop’. This ‘drop’ usually occurs for most droplets in under 1 m from the source and relatively quickly (less than a few minutes). However, how far droplets travel and how long they might stay suspended in air are also dependent on multiple other factors, including shouting, singing, repeated coughing, air movement and humidity. Therefore, longer distances than 1 m are often recommended for physical distancing when trying to decrease the risk of spread, for example, 1.5 m in Australia,¹³ and some even 6 ft (approximately 2 m).¹¹ All recommend at least 1 m for physical distancing, but the risk is not dependent on a fixed distance.¹⁶ Being closer than 1 m to someone with COVID-19 is more of a risk than being 1.5 m and more of a risk than being separated by 2 m, and likely dependent on the number of droplets deposited on mucosal surfaces (including the eyes).

Much smaller infectious particles (i.e. aerosols and those that are usually <5 µm in size) carrying virus are also produced by people with COVID-19 and can cause infections. However, they are unlikely to be a major factor in transmission unless produced in large numbers (e.g. by some medical procedures) or in some more high-risk situations.^{10,14,17,18} Reports where infections are acquired by someone who is more than 2 m from an infected individual appear often to be related to poor air circulation, and who are often ‘downwind’ from those infected.¹⁹ These secondary infections are still likely to be the results of larger particles, such as droplets, just

that some droplets were carried further by the way the air was circulating. Unlike droplets, aerosols can stay suspended in the air for many hours.^{10–14,17,18} If aerosols were a predominant mechanism for infection, we would expect many others in the same rooms, buildings, bus or planes as an infected individual, or after they leave, to become infected. This would include many who were not directly in line with the airflow and to see much higher infection rates in households. However, transmission rates, even in households where people are close together for 2 weeks or more, are usually less than 20%.^{10,20}

Why is droplet transmission so important for effective preventative strategies?

As with SARS-CoV-2, droplets appear to be the main way that most respiratory pathogens spread (e.g. influenza, meningococcus).^{21–23} When influenza infections in health-care workers are looked at, to see if respirators might better prevent the inhalation of aerosols (e.g. P2/N95 masks compared with surgical masks), most large studies and reviews,^{18,23–26} but not all,²⁷ report that there are no consistent and statistically significant differences in infection rates between health-care workers wearing surgical masks compared with those who used respirators/N95 masks. However, cloth masks appear to be less effective.²⁸

The knowledge that droplets are the major route for spread makes the potential control of COVID-19 less problematic than if aerosols were the predominant or a major pathway for transmission. It means physical distancing will markedly decrease the risk of transmission. Hand washing/hand hygiene will also likely make some difference, because droplets fall on surfaces. The virus deposited on surfaces through droplets can then be picked up by hands. People can then self-inoculate themselves by touching their nose, mouth or eyes and become infected.

Droplet transmission also means that personal protective equipment that protects the respiratory tract as well as eyes, such as surgical face masks and face shields, can give high levels of protection to the wearer. Additionally, masks and face shields, if handled and worn properly, will also decrease the risk of spreading infection to others. This is because if you wear a mask and/or face shield, and you are infected, if you talk, cough or sneeze, it limits how far virus laden droplets will travel. Clear, plastic face-shields will likely give added protection to wearing just a mask because they protect the whole of the face, including the eyes. Additionally, they decrease the risk of unintentionally touching our face with our hands.²⁹ This is a very important issue in communities

where there are high levels of transmission and in areas where there is a much higher prevalence of disease, for example, quarantine hotels, and in hospital wards with COVID-19 patients. These higher risk areas are where infections might be acquired more easily and therefore might also spread more easily.

While those who are asymptomatic or pre-symptomatic can spread the virus, most spread likely occurs from people who have symptoms.¹⁰ Thus, keeping away from the workplace and associating with others when we have any respiratory symptoms is a vital part of 'isolation and social distancing', even though frequently this was not done by many, including health-care workers, in the past.³⁰

Which interventions work to stop the spread of SARS-CoV-2?

There are many measures that have been put in place to control the spread of COVID (see Table 1). However, in practice, they are not used alone, but in combination.

Australia has been very successful at limiting repeated reintroduction of SARS-CoV-2 into the general community by the early closure of international borders, which has limited spread from high prevalence countries/regions (e.g. USA) and by quarantining all returned international travellers.

Table 1 Interventions to control the spread of COVID-19

Interventions to limit the direct and indirect spread, especially by droplets	
•	Limiting the number of people that may meet in a group, especially indoors
•	Encouraging individuals to practise social and physical distancing
•	The effective use of personal protective equipment (PPE), such as masks and face shields
•	People who are unwell staying away from others and their workplace
•	Encouraging individuals to undertake regular hygiene/hand washing
Limiting the movements of people	
•	Isolate† all people with infection
•	Quarantine† all close contacts of cases of COVID-19
•	Quarantine all arrivals from higher prevalence countries or regions
•	Closing international borders
•	Prevention or limitation of the movements of persons geographically within or between a State/Territory or other defined area (including stay-at-home directions, maximum-distance-travel-from-home directions and regulations preventing movement into and out of particular locations)
Intervention to find infected individuals	
•	Facilitating timely contact tracing
•	Increasing the testing of potential COVID-19 cases
•	Testing those with any symptoms

†The differences between isolation and quarantine are given in U.S. Department of Health and Human Services.³¹

If SARS-CoV-2 is circulating in a community, then effective ways to stop the spread are to prevent or reduce the spread of droplets, especially indoors, from person to person. Such interventions include physical distancing, keeping away from others who are sick with respiratory symptoms, staying away from others when you are sick, the isolation of infected cases and quarantining of close contacts of those with COVID-19 cases. The use of appropriate PPE (especially face masks and face shields) in higher risk situations and at times of higher community transmission is also very important. Eye protection is underappreciated and needs to be given more prominence.³² Hand hygiene is important but will have a lower impact on transmission of COVID-19 than physical distancing because most spread is likely in the air directly from droplets into the respiratory tract or eyes, rather than indirectly through hands.

Containing the spread of COVID-19

However, the extent of what we need to do about isolation and social distancing will vary over time. It should be proportionate to the level of COVID-19 transmission in a community or risk levels in workplaces (e.g. quarantine hotels, staff rooms in hospitals). The definitions of what is a crowd for instance might vary as the prevalence of infection rises or falls in defined regions, as will rules allowing the numbers of people into venues. But the basic principles underlying what makes transmission of COVID-19 less likely, that is, physical distancing, control of crowds especially indoors, hand hygiene and quarantining, as well as ongoing extensive polymerase chain reaction (PCR) testing, will need to continue.

The peak of the first wave of new cases in Australia was around 20 March 2020.³³ The subsequent decrease in cases occurred because most of the Australian population appeared to be following recommendations from our health authorities, which involved predominantly social distancing and isolation/quarantining. People appeared to be following physical and social distancing recommendations from mid-March, as judged by data using Google in Australia, and elsewhere.^{34,35} In addition, the effect of added actions and regulations that kept crowd numbers down and closure of places where large groups could mingle together, especially indoors, appears to be of major benefit. Examples were the closure of restaurants, bars, clubs, gyms, pubs and churches. Many of these indoor venues have been shown to have been associated with large outbreaks, both internationally and in Australia.

Suppressing or eliminating COVID-19?

When initial interventions to limit spread were done in Australia and worldwide, generally it was intended to ‘flatten the curve’.^{36,37} This meant that instead of allowing the numbers of new cases to continue to rise per day, as was occurring and often rising exponentially, that restrictions and interventions would cause the number of new cases per day to level off. The level and severity of restrictions put in place would be tailored so that the numbers of new cases occurring per day would be such that the health system could cope and not be overwhelmed.

In Australia, during our first wave in March/April 2020, we did much better than just ‘flattening the curve’. The epidemic curve of daily cases decreased rapidly after about 26 March and we had very low numbers of new cases per day by mid to late April.³³ This resulted in very effective suppression of cases. It was similar to what was seen in Korea during their first wave, and their public health interventions turned their epidemic curve around as well.³⁸ This was also the case for New Zealand.³⁹

After this very successful suppression, some areas (e.g. New Zealand in March 2020 and then Victoria) started aiming for elimination strategies,^{40,41} with more prolonged lockdowns compared with most states in Australia. The supposition being that if lockdowns continued so that no new cases were seen for two or more incubation periods (i.e. 28 days), then it was likely the virus was eliminated from those areas. However, in both Victoria and New Zealand there have been subsequent outbreaks of COVID-19. It is of note that the genomics on new outbreaks that have occurred in Australia and New Zealand since late 2020 show that all new outbreaks were caused by newly introduced strains. This suggests that everywhere in Australia and New Zealand, including Sydney with large cases numbers, that for periods of time, the virus was eliminated before new strains were again reintroduced and started new outbreaks.^{42,43}

However, elimination will be very difficult to maintain in large populations over time, given how widespread COVID-19 is globally. The symptoms in people who are aged in their 20s and 30s are mostly very mild and/or asymptomatic. Yet they can still pass on the virus to others. Even if we are not seeing cases, it can still be likely that in some areas there might be ongoing low-level transmission occurring, even if no cases are found for many weeks or even months.

Even when the SARS-CoV-2 virus is eliminated from certain populations, if ‘isolation and social distancing’ measures are not retained, at least in part, when the virus is reintroduced, it can spread very rapidly,

especially in winter. New case numbers can quickly escalate, as evidenced by not only what has happened in Melbourne in the winter of 2020, but also in Korea and in Auckland.^{43,44} Korea, with its control of COVID-19, was very similar to Australia after our first wave, but when Korea reopened facilities where indoor crowding was more likely, particularly bars and nightclubs, there was a rapid increase of new cases,⁴⁴ which has worsened over their winter of 2020/2021.⁴⁵

Globally, Taiwan appears to be the only country with a population of over a few million that has so far achieved and then maintained ‘elimination’ without recurrences in the community.⁴⁶ Of note, Taiwan also did this without major lockdowns.

What effect will a vaccine have?

All, or most of the interventions in Table 1, will need to be continued until very effective and safe vaccines become widely available and used, not only in Australia but globally. Even in wealthy countries like Australia and New Zealand, most of the population is unlikely to be vaccinated before late 2021. This is because of the time needed to complete and evaluate the necessary large and ongoing phase 3 studies, changes in virus with time, the regulatory approval of vaccines, the development of vaccines for children plus then the time needed to manufacture and distribute effective vaccines in large numbers. Globally, this will take many years. Also, vaccines will likely decrease the transmission of SARS-CoV-2, but maybe not do so as effectively as they will be in decreasing the risk of people dying and developing serious disease.⁴⁷ Achieving herd immunity through vaccination also has many challenges and may be difficult to sustain.⁴⁸

We have, to date, few examples of good control of respiratory viruses, yet alone elimination. Measles and rubella are two respiratory infections that have been ‘eliminated’ within Australia (although not eliminated or eradicated globally). Vaccines against those viruses have efficacies of more than 90%, but they took long periods to develop and to become widely available.⁴⁹

What was done in previous pandemics?

In previous centuries, pandemics have occurred frequently. Pandemics have been caused by numerous different viruses and bacteria. Examples include influenza, typhus, cholera, smallpox, plague and typhoid.^{50–52} During the 19th century there were frequent (every 20 years) pandemics due to cholera. A common feature for all these pandemics was that isolation and social

distancing was always used as a means to decrease the extent and spread of these infections, even when spread was by water (e.g. cholera). Clean or boiled water plus improved sanitation are the most obvious answers to water borne pathogens. However, by limiting the movement of people, this also limited the number of people that anyone who is infected encounters. Limiting travel also decreases the risk that someone with a gastrointestinal infection, for example cholera, would introduce bacteria into new waterways from where others might drink. Recently, a large cholera epidemic was caused by UN peacekeepers from Nepal coming into Haiti and then contaminating waterways.⁵³

While isolation of infected individuals (e.g. with leprosy) was been done for millennia, quarantine (40 days of isolation, even for people not showing disease) was first introduced much later in 1377 to control plague.^{50,51} Leprosariums and sanatoriums were in place well before the causative microorganisms were known for leprosy and tuberculosis, respectively, and were known or their mechanisms of spread. All these 'isolation' interventions likely decreased the transmission of bacteria causing those diseases.

Conclusion

The risk and spread of COVID-19 can be reduced by many interventions, and these are primarily those that reduced the risk of people coming into direct exposure to respiratory droplets produced by other people. Most of the principles underpinning successful interventions relate to isolation and social distancing. These will need to be continued until safe and very effective vaccines become widely available.

Therefore, this new norm will be with us for some time to come and be with us also in any future pandemics caused by viruses that spread predominantly through the respiratory route. We will also need continued widespread PCR and/or antigen testing of those with respiratory symptoms so that we can have continuous and reliable estimates of the prevalence and the

incidence of infections in Australia and New Zealand and elsewhere. This may be supplemented by antibody testing. Testing sewage for the presence of the virus causing COVID-19 will also help to better find areas where there are or likely to be new outbreaks and to also determine the level of COVID-19 infections in different communities and localities.

The new norm for travel and our interactions with others will be varying degrees of restrictions on movements, isolation and social distancing, but the levels of restrictions will vary with time depending on community transmission levels. However, we need to be aware that lockdowns and restrictions also can cause many adverse economic, social and other adverse health consequences. WHO notes that lockdowns can have profound negative impacts on individuals, communities and societies by bringing social and economic life to a near stop. The effects of lockdowns disproportionately affect disadvantaged groups and WHO recommends using more targeted interventions.⁵⁴ As recently commented in an editorial in the *Internal Medicine Journal*, 'public health agencies have a responsibility to consider how to achieve overall public health goals but with the least restrictive or burdensome strategies, and to weigh each intervention on its merits'.⁵⁵

Will we always have to live like this from now? Probably not. If we have vaccines that are more than 90% effective in preventing disease and preventing the spread of the virus and they are delivered and taken up globally by more than 80% of the population, then there is a very good chance the virus can be suppressed to remain at very low levels or even eliminated and elimination maintained – at least in countries with good health systems and other infrastructure. However, even if this global ideal is not reached, if we look at previous pandemics since the 1800s, eventually between a mixture of decreasing virulence of the circulating pathogen, herd immunity and the use of interventions that interfere with the spread of the causative organisms, the pandemics decrease in severity and size with time – although unfortunately not usually for many years.

References

- 1 World Health Organization (WHO). Timeline: WHO's COVID-19 response. Geneva: WHO [cited 2021 Mar 1]. Available from URL: https://www.who.int/emergencies/diseases/novel-coronavirus-2019/interactive-timeline?gclid=Cj0KCQjwit_8BRCoARIsAIX3Rj5njXiX_Z7ewkI3B4Ty3GvrkersKveTJXOiViy45qvW44QqJ2qhUa4aAhH9EALw_wcB#event-115
- 2 European Centre for Disease Prevention and Control (ECDC). Timeline of ECDC's response to COVID-19. Stockholm: ECDC; 2020 [cited 2021 Mar 1]. Available from URL: <https://www.ecdc.europa.eu/en/covid-19/timeline-ecdc-response>
- 3 Walsh NP. WHO Wuhan mission finds possible signs of wider original outbreak in 2019. CNN [updated 2021 Feb 15; cited 2021 Mar 1]. Available from URL: <https://edition.cnn.com/2021/02/14/health/who-mission-china-intl/index.html>
- 4 Deslandes A, Berti V, Tandjaoui-Lambotte Y, Alloui C, Carbone E, Zahar JR *et al*. SARS-CoV-2 was already spreading in France in late December 2019. *Int J Antimicrob Agents* 2020; **55**: 106006.
- 5 Basavaraju SV, Patton ME, Grimm K, Rasheed MAU, Lester S, Mills L *et al*. Serologic testing of US blood donations to identify severe acute respiratory

- syndrome coronavirus 2 (SARS-CoV-2)-reactive antibodies. *Clin Infect Dis* 2020; **ciaa1785**.
- 6 Fauci AS, Lane HC, Redfield RR. Covid-19 – navigating the uncharted. *N Engl J Med* 2020; **382**: 1268–9.
 - 7 Meyerowitz-Katz G, Merone L. A systematic review and meta-analysis of published research data on COVID-19 infection-fatality rates. *Int J Infect Dis* 2020; **101**: 138–48.
 - 8 Collignon P, Beggs J. COVID-19 fatality risk: why is Australia lower than South Korea? *medRxiv*. 2020.05.14.20101378. <https://doi.org/10.1101/2020.05.14.20101378>.
 - 9 Levin A, Hanage W, Owusu-Boaitey N, Cochran K, Walsh S, Meyerowitz-Katz G. Assessing the age specificity of infection fatality rates for COVID-19: systematic review, meta-analysis, and public policy implications. *medRxiv* 2020. <https://doi.org/10.1101/2020.07.23.20160895>.
 - 10 Cevik M, Kuppalli K, Kindrachuk J, Peiris M. Virology, transmission, and pathogenesis of SARS-CoV-2. *BMJ* 2020; **371**: m3862.
 - 11 Centres for Disease Control and Prevention (CDC). Coronavirus Disease 2019 (COVID-19). How It Spreads. Atlanta: CDC; 2020 [cited 2021 Mar 1]. Available from URL: <https://www.cdc.gov/coronavirus/2019-ncov/prevent-getting-sick/how-covid-spreads.html>
 - 12 World Health Organization (WHO). Modes of transmission of virus causing COVID-19: implications for IPC precaution recommendations. Scientific Brief. Geneva: WHO; 2020 [cited 2021 Mar 1]. Available from URL: <https://www.who.int/news-room/commentaries/detail/transmission-of-sars-cov-2-implications-for-infection-prevention-precautions>
 - 13 Australian Government, Department of Health. What you need to know about coronavirus (COVID-19). Canberra: Australian Government, Department of Health; 2021 [cited 2021 Mar 1]. Available from URL: <https://www.health.gov.au/news/health-alerts/novel-coronavirus-2019-ncov-health-alert/what-you-need-to-know-about-coronavirus-covid-19>
 - 14 Jayaweera M, Perera H, Gunawardana B, Manatunge J. Transmission of COVID-19 virus by droplets and aerosols: a critical review on the unresolved dichotomy. *Environ Res* 2020; **188**: 109819.
 - 15 European Centre for Disease Prevention and Control (ECDC). Heating, ventilation and air-conditioning systems in the context of COVID-19. Sweden: ECDC; 2020 [cited 2021 Mar 1]. <https://www.ecdc.europa.eu/sites/default/files/documents/Ventilation-in-the-context-of-COVID-19.pdf>
 - 16 Shukman D. Coronavirus: Could social distancing of less than two metres work? 2020 [cited 2021 Mar 1]. Available from URL: <https://www.bbc.com/news/science-environment-52522460>
 - 17 Australian Government, Department of Health. Coronavirus (COVID-19) – Recommended minimum requirements for the use of masks or respirators by health and residential care workers in areas with significant community transmission. Canberra: Australian Government, Department of Health; 2020 [cited 2021 Mar 1]. <https://www.health.gov.au/resources/publications/iceg-guidance-masks-respirators-health-residential-care-workers>
 - 18 Conly J, Seto WH, Pittet D, Holmes A, Chu M, Hunter PR *et al*. Use of medical face masks versus particulate respirators as a component of personal protective equipment for health care workers in the context of the COVID-19 pandemic. *Antimicrob Resist Infect Control* 2020; **9**: 1–7.
 - 19 Lu J, Yang Z. COVID-19 outbreak associated with air conditioning in restaurant, Guangzhou, China, 2020. *Emerg Infect Dis* 2020; **26**: 2791–3.
 - 20 Li W, Zhang B, Lu J, Liu S, Chang Z, Cao P *et al*. The characteristics of household transmission of COVID-19. *Clin Infect Dis* 2020; **71**: 1943–6. <https://doi.org/10.1093/cid/ciaa450>
 - 21 Centres for Disease Control and Prevention (CDC). Clinical Syndromes or Conditions Warranting Empiric Transmission-Based Precautions in Addition to Standard Precautions. Guideline for Isolation Precautions: Preventing Transmission of Infectious Agents in Healthcare Settings. Atlanta: CDC; 2007 [cited 2021 Mar 1]. <https://www.cdc.gov/infectioncontrol/guidelines/isolation/appendix/transmission-precautions.html>
 - 22 World Health Organization (WHO). Coronavirus disease (COVID-19): Similarities and differences with influenza. Geneva: WHO; 2020 [cited 2021 Mar 1]. Available from URL: https://www.who.int/emergencies/diseases/novel-coronavirus-2019/question-and-answers-hub/q-a-detail/q-a-similarities-and-differences-covid-19-and-influenza?gclid=Cj0KCQjwit_8BRCoARIsAlx3Rj5GFHmKb6zS3ydCiofNbO45BPWNbEazVD-XH_4zYS28dt7BUkak14kaAl5KEALw_wcB
 - 23 Jefferson T, Del Mar CB, Dooley L, Ferroni E, Al-Ansary LA, Bawazeer GA *et al*. Physical interventions to interrupt or reduce the spread of respiratory viruses. *Cochrane Database Syst Rev* 2011; **CD006207**.
 - 24 Smith JD, MacDougall CC, Johnstone J, Copes RA, Schwartz B, Garber GE. Effectiveness of N95 respirators versus surgical masks in protecting health care workers from acute respiratory infection: a systematic review and meta-analysis. *CMAJ* 2016; **188**: 567–74.
 - 25 Offeddu V, Yung CF, Low MSF, Tam CC. Effectiveness of masks and respirators against respiratory infections in healthcare workers: a systematic review and meta-analysis. *Clin Infect Dis* 2017; **65**: 1934–42.
 - 26 Long Y, Hu T, Liu L, Chen R, Guo Q, Yang L *et al*. Effectiveness of N95 respirators versus surgical masks against influenza: a systematic review and meta-analysis. *J Evid Based Med* 2020; **13**: 93–101.
 - 27 Chu DK, Akl EA, Duda S, Solo K, Yaacoub S, Schünemann HJ. COVID-19 Systematic Urgent Review Group Effort (SURGE) study authors. Physical distancing, face masks, and eye protection to prevent person-to-person transmission of SARS-CoV-2 and COVID-19: a systematic review and meta-analysis. *Lancet* 2020; **395**: 1973–87.
 - 28 Chughtai AA, Seale H, Macintyre CR. Effectiveness of cloth masks for protection against severe acute respiratory syndrome coronavirus 2. *Emerg Infect Dis* 2020; **26**: e200948.
 - 29 Perencevich EN, Diekema DJ, Edmond MB. Moving personal protective equipment into the community: face shields and containment of COVID-19. *JAMA* 2020; **323**: 2252–3.
 - 30 Tartari E, Saris K, Kenters N *et al*. Not sick enough to worry? “Influenza-like”

- symptoms and work-related behavior among healthcare workers and other professionals: results of a global survey. *PLoS One* 2020; **15**: e0232168.
- 31 U.S. Department of Health and Human Services. What is the difference between isolation and quarantine? 2020 [cited 2021 Feb 22]. Available from URL: <https://www.hhs.gov/answers/public-health-and-safety/what-is-the-difference-between-isolation-and-quarantine/index.html>
- 32 Coroneo M, Collignon P. SARS-CoV-2: eye protection might be the missing key. *Lancet Microbe* 2021; **2**: e173–e174.
- 33 Australian Government, Department of Health. Daily and cumulative number of reported COVID-19 cases in Australia. Canberra: Australian Government, Department of Health; 2021 [cited 2021 Mar 1]. Available from URL: <https://www.health.gov.au/news/health-alerts/novel-coronavirus-2019-ncov-health-alert/coronavirus-covid-19-current-situation-and-case-numbers#daily-reported-cases>
- 34 Golding N, Freya M, Shearer F, Moss R, Dawson P, Gibbs L *et al*. Estimating temporal variation in transmission of COVID-19 and adherence to social distancing measures in Australia. Technical Report 15 May 2020. Melbourne: Doherty Institute; 2020 [cited 2021 Mar 1]. Available from URL: https://www.doherty.edu.au/uploads/content_doc/Technical_report_3.pdf
- 35 Badr HS, Du H, Marshall M, Dong E, Squire MM, Gardner LM. Association between mobility patterns and COVID-19 transmission in the USA: a mathematical modelling study. *Lancet Infect Dis* 2020; **20**: 1247–54.
- 36 Queensland Government. Flattening the Curve. Brisbane: Queensland Government; 2020 [cited 2021 Mar 1]. Available from URL: <https://www.qld.gov.au/health/conditions/health-alerts/coronavirus-covid-19/stay-informed/flattening-the-curve>.
- 37 Roberts S. Flattening the Coronavirus Curve. *New York Times* 2020 Mar 27 [cited 2021 Mar 1]. Available from URL: <https://www.nytimes.com/article/flatten-curve-coronavirus.html>
- 38 Central Disease Control. Coronavirus Disease-19. Republic of Korea: Central Disease Control; 2021 [cited 2021 Mar 1]. Available from URL: <http://ncov.mohw.go.kr/en/>
- 39 Ministry of Health, New Zealand. COVID-19: Data and Statistics. Wellington: Ministry of Health, New Zealand; 2020 [cited 2021 Mar 1]. Available from URL: <https://www.health.govt.nz/our-work/diseases-and-conditions/covid-19-novel-coronavirus/covid-19-data-and-statistics>
- 40 Coronavirus cases in Victoria rise by seven as Chief Health Officer flags total elimination of virus in Australia. *ABC News* [cited 2021 Mar 1]. Available from URL: <https://www.abc.net.au/news/2020-04-21/coronavirus-elimination-viable-option-victoria-cho-brett-sutton/12166956>
- 41 Baker MG, Wilson N, Anglemeyer A. Successful elimination of Covid-19 transmission in New Zealand. *N Engl J Med* 2020; **383**: e56.
- 42 Lyons E. Coronavirus: Genomic sequencing shows Sydney's northern beaches cluster linked to United States. *The Australian* 2020 Dec 18 [cited 2021 Feb 22]. Available from URL: <https://www.theaustralian.com.au/breaking-news/northern-beaches-cluster-linked-to-overseas-virus-strain/news-story/1c733146058b81954662541cf19185c0>
- 43 Wilson N, Grout I, Baker m. How best to classify and count NZ's border control failures in the COVID-19 pandemic? *Public Health Expert* 2021 Feb 12 [cited 2021 Feb 22]. <https://blogs.otago.ac.nz/pubhealthexpert/how-best-to-classify-and-count-nzs-border-control-failures-in-the-covid-19-pandemic/>
- 44 Choe S-H. As South Korea Eases Limits, Virus Cluster Prompts Seoul to Close Bars. *New York Times* 2020 May 9 [cited 2021 Mar 1]. Available from URL: <https://www.nytimes.com/2020/05/09/world/asia/coronavirus-south-korea-second-wave.html>
- 45 Strumer J, Asada Y. Coronavirus was largely under control in South Korea and Japan. Here's why COVID-19 cases are now spiralling. *ABC News* 2020 Dec 17 [cited 2021 Feb 22]. Available from URL: <https://www.abc.net.au/news/2020-12-17/japan-and-south-korea-are-struggling-with-coronavirus/12984136>
- 46 Summers DJ, Cheng DH-Y, Lin PH-H *et al*. Potential lessons from the Taiwan and New Zealand health responses to the COVID-19 pandemic. *Lancet Regional Health* 2020; **4**: 100044.
- 47 Gorvett Z. Can you still transmit Covid-19 after vaccination? *BBC* 2021 Feb 3 [cited 2021 Feb 22]. Available from URL: <https://www.bbc.com/future/article/20210203-why-vaccinated-people-may-still-be-able-to-spread-covid-19>
- 48 Anderson RM, Vegvari C, Truscott J, Collyer BS. Challenges in creating herd immunity to SARS-CoV-2 infection by mass vaccination. *Lancet* 2020; **396**: 1614–16.
- 49 Australian Technical Advisory Group on Immunisation (ATAGI). Australian Immunization Handbook. Canberra: Australian Government, Department of Health; 2018 [cited 2021 Feb 22]. Available from URL: <https://immunisationhandbook.health.gov.au/>.
- 50 Gensini GF, Yacoub MH, Conti AA. The concept of quarantine in history: from plague to SARS. *J Infect* 2004; **49**: 257–61.
- 51 Bassareo PP, Melis MR, Marras S, Calcaterra G. Learning from the past in the COVID-19 era: rediscovery of quarantine, previous pandemics, origin of hospitals and national healthcare systems, and ethics in medicine. *Postgrad Med J* 2020; **96**: 633–8.
- 52 Wikipedia. Pandemic. [cited 2021 Mar 1]. Available from URL: <https://en.wikipedia.org/wiki/Pandemic>
- 53 Katz J. U.N. Admits Role in Cholera Epidemic in Haiti. *New York Times* 2016 Aug 17 [cited 2021 Mar 1]. Available from URL: <https://www.nytimes.com/2016/08/18/world/americas/united-nations-haiti-cholera.html>
- 54 World Health Organization (WHO). Coronavirus disease (COVID-19): Herd immunity, lockdowns and COVID-19. Geneva: WHO; 2020 [cited 2021 Mar 2]. Available from URL: <https://www.who.int/news-room/q-a-detail/herd-immunity-lockdowns-and-covid-19>
- 55 Jamrozik E, Heriot GS. Pandemic public health policy: with great power comes great responsibility. *Intern Med J* 2020; **50**: 1169–73.