

## COVID-19 RISK ASSESSMENT SUMMARY Published: 6 August 2020

### RISK SUMMARY:

This assessment is undertaken based on the information available on 03 August 2020.

This remains a rapidly evolving situation worldwide, the level of uncertainty remains **HIGH**, therefore this assessment takes a precautionary approach.

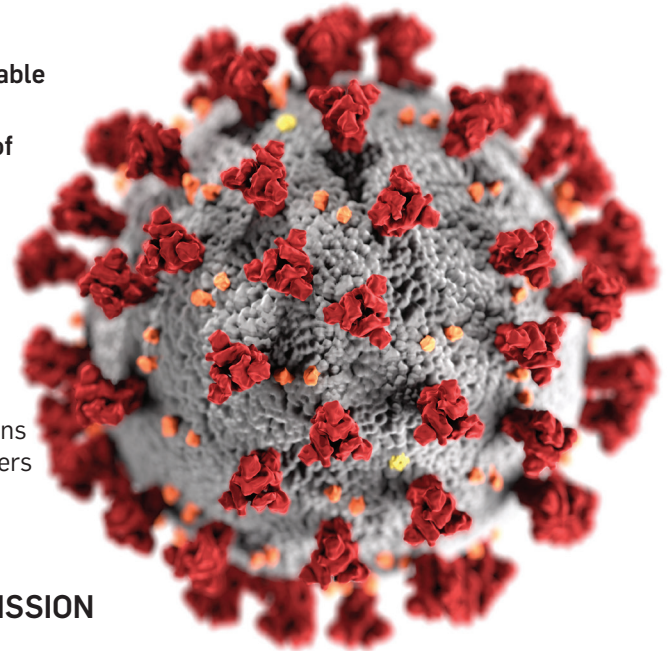


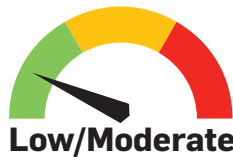
Photo: CDC Atlanta

### IMPORTATION RISK:



High

Even with the containment and borders measures in place in other countries and the border measures and containment measures currently in place in New Zealand, there remains a **HIGH** likelihood of importations from travellers to New Zealand, due to ongoing high rates of infection worldwide.



Low/Moderate

### ASSESSMENT OF RISK OF TRANSMISSION WITHIN NEW ZEALAND:

Given the current border and quarantine measures in place, the likelihood of transmission outside of isolation bubbles within quarantine facilities is **LOW-MODERATE**. The likelihood of transmission outside of quarantine facilities is currently **LOW**. This assessment assumes that cases in quarantine facilities are detected in a timely manner and that infection prevention and control measures are implemented promptly.



High

### PUBLIC HEALTH IMPACT OF COVID-19 IN NEW ZEALAND:

The impact on the sector and the public from COVID-19 has been significant. The public health impact remains **HIGH** for public health staff, the wider health sector and the community.

### PUBLIC HEALTH RISK:

Given the assessment of the likelihood of importation, the likelihood of transmission in New Zealand and the public health impact, the overall public health risk from this event remains **HIGH**.

### RISK ASSESSMENT REFERENCE SCALE:

**VERY LOW/NEGLIGIBLE** to **VERY HIGH**

### NOTES:

In addition to this summary assessment, ESR are also publishing a public dashboard: <https://nzcoviddashboard.esr.cri.nz/#!/> for COVID-19.

This assessment is based on the ECDC risk assessment methodology.<sup>[1]</sup>

This assessment is reviewed by the ESR incident management team. This team includes epidemiologists, health intelligence analysts, public health medicine specialists, a clinical virologist, laboratory scientists, informaticians and bioinformaticians. The team has in-depth experience in leading, and supporting national and local communicable disease responses, including emerging infectious diseases, such as SARs, influenza, MERS, zika and Ebola.

The team has extensive experience in providing fit-for-purpose health intelligence services during response situations.

## EVENT BACKGROUND/SUMMARY:

On 31 December 2019 a cluster of pneumonia cases of unknown aetiology was reported in Wuhan City, Hubei province, China. On 9 January 2020, the causative agent was reported to be a novel coronavirus.<sup>[2]</sup> The WHO have confirmed that the disease caused by this novel coronavirus is to be called COVID-19 and the International Committee on Taxonomy of Viruses have designated the official name for the causative virus to be SARS-CoV-2.<sup>[3]</sup>

The Director General of the WHO declared that the novel coronavirus outbreak constituted a public health emergency of international concern on 30 January 2020,<sup>[4]</sup> and on 11 March declared a pandemic.<sup>[5]</sup>

As of 02 August 2020 there had been 17,660,523 confirmed cases of COVID-19 including 680,894 deaths reported to WHO.<sup>[6]</sup> The WHO Region with the highest number of reported cases to date is the Americas (9,476,763), followed by Europe (3,375,535).<sup>[7]</sup> Countries reporting over 50,000 new cases in the prior 24 hours to 02 August included the United States of America, Brazil, and India.<sup>[7]</sup>

As of 09:00, 02 August 2020, there have been 1215 confirmed and 350 probable cases reported in New Zealand.<sup>[8]</sup> There have been 22 deaths reported in New Zealand. Since mid-June, all cases in New Zealand have been detected in people in managed isolation on return to New Zealand from overseas.

## Hazard Identification

There is accumulating information on the epidemiological and clinical characteristics of SARS-CoV-2 infection, though there is still significant uncertainty. There is currently no vaccine or specific treatment available, although a number of investigational approaches are being explored (register of clinical trials at [clinicaltrials.gov](https://clinicaltrials.gov)), including antiviral therapies and convalescent plasma. National and International guidance to date is based largely on management and control of other respiratory illnesses.

## Spectrum, severity of disease and vulnerable populations

The spectrum of symptomatic infection ranges from mild to critical.<sup>[9-15]</sup> The three major patterns of clinical course of infection seem to be mild illness with upper respiratory tract symptoms, non-life threatening pneumonia and severe pneumonia with acute respiratory distress syndrome (ARDS) that begins with mild symptoms for 7-8 days followed by rapid deterioration to requirements for high and intensive dependency care.<sup>[16]</sup> The major complication of COVID-19 is ARDS. In addition severe COVID-19 has been linked to cardiovascular sequelae, acute kidney injury, neurological complications and acute ischemic stroke.<sup>[17]</sup>

In the WHO–China Joint Mission on COVID-19, disease was mild to moderate in 80% of 55,924 cases, 13.8% had severe disease, 6.1% were critical.<sup>[14]</sup> This pattern is consistent with other data including that from the Chinese Center for Disease Control and Prevention and the ISARIC COVID-19 database.<sup>[17,18]</sup>

The WHO–China Joint Mission on COVID-19 found that among 55,924 cases, the most common signs and symptoms were fever (87.9%), dry cough (67.7%), fatigue (38.1%), sputum production (33.4%), shortness of breath (18.6%), sore throat (13.9%), headache (13.6%) and myalgia or arthralgia (14.8%).<sup>[14]</sup> Less common symptoms have included rhinorrhoea and gastrointestinal symptoms such as nausea and diarrhoea. Smell and taste disorders have also been reported as common symptoms in patients with COVID-19, with 34% of cases in a survey of 59 patients with COVID-19 in Italy self-reporting either a smell or taste aberration and 19 percent reported both.<sup>[19]</sup> Similar symptom profiles have also been reported in New Zealand and other countries.

Individuals at the highest risk for severe disease and death are people aged over 60 years and those with underlying conditions such as hypertension, diabetes, cardiovascular disease, chronic respiratory disease, chronic kidney disease and cancer.<sup>[14, 20, 21]</sup>

Health workers and carers are at high risk of infection<sup>[16, 22-25]</sup>, although analysis of case-based surveillance data of 124,796 cases by ECDC showed that health care workers were less likely to be hospitalised compared to non-health care workers (9% versus 17%), and were less likely to present with severe illness requiring ICU admission or respiratory support compared with non-health workers (1% versus 5%).<sup>[28]</sup>

A study of 191 adult patients in Wuhan found the median time from illness onset to discharge was 22 days and the median time to death was 18.5 days.<sup>[20]</sup> A study of outcomes in 52 critically ill adult COVID-19 cases in Wuhan found 61.5% of the critically ill patients had died at 28 days, the median duration of admission to intensive care to death was seven days. The non-survivors tended to be older (64.6 years versus 51.9 years), were more likely to develop ARDS (81% of non-survivors versus 45% of survivors) and more likely to require mechanical ventilation (94% versus 35%).<sup>[26]</sup>

While COVID-19 infections have been less frequently reported in children and children tend to present with milder

symptoms compared with adults<sup>[27]</sup>, there have been reports from several countries of a possible temporal association between COVID-19 and a rare paediatric inflammatory multisystem syndrome in children.<sup>[17]</sup>

Prior to the wide availability of COVID-19 testing, between March 12 and 16, a rapid sentinel surveillance study was carried out in Los Angeles to determine what proportion of mild, outpatient influenza like illnesses were caused by COVID-19.<sup>[28]</sup> Of 131 patients tested, 5% were positive for COVID-19, none had specific risk factors for infection, and all were well enough to have been active in the community throughout their infection.<sup>[28]</sup> Authors note that sentinel testing had revealed a third seasonal spike in influenza-like illnesses during the weeks before the study, with declining influenza positivity,<sup>[28]</sup> likely due to unrecognised SARS-CoV-2.

### Case fatality

According to the WHO situation report of 02 August 2020, of the confirmed cases worldwide 3.86% have died.<sup>[6, 29]</sup> The currently reported global fatality rates are lower than those reported for MERS-CoV (34%) and SARS (10%).<sup>[16, 30]</sup>

Published studies of early cases in China report mortality rates among hospitalised patients of 1.18- 4.3%, and 11%.<sup>[22-25]</sup> Reported case fatality rates vary widely over time and between countries, from over 13% in France, Belgium, Italy, the UK and to 0.06% in Singapore.<sup>[31]</sup> Case fatality ratios depend in part on sensitivity of different surveillance systems to detect cases of differing levels of severity, selection bias towards testing of more severe cases, delays between onset of symptoms and death, healthcare, patient demographics, comorbidities and differences in how deaths are attributed to COVID-19.<sup>[31]</sup>

A study published on 30 March estimated case fatality and infection fatality ratios using case data from mainland China and 37 other countries. When adjusted for demography and under-ascertainment of milder cases in Wuhan, the best estimate of the case fatality ratio in China was 1.38% (95% CrI 1.23–1.53), with substantially higher ratios in older age groups (0.32% in those aged <60 years compared to 6.4% in those aged ≥60 years), up to 13.4% in those aged 80 years or older. Estimates of case fatality ratio from international cases stratified by age were consistent with those from China (1.4% in those aged <60 years [n=360] and 4.5% in those aged ≥60 years. Authors estimated an infection fatality rate for China of 0.66% (95% CrI 0.39–1.33%), again with higher IFR for older ages.<sup>[32]</sup>

Data from passengers on the Diamond Princess was used to estimate a CFR of 2.3% and an IFR of 1.2%. Comparing these deaths with the expected deaths in China the CFR and IFR were estimated to be 1.1% and 0.5%, respectively, in China.<sup>[33]</sup>

Data from the first patients in the USA indicates that fatality was highest in patients aged 85 and over (10–27%), followed by 3–11% among patients aged 65–84 years, 1–3% for those aged 55–64 and <1% for those aged 20–54 years. No fatalities were recorded among persons 19 years and under.<sup>[34]</sup>

### Asymptomatic infection

Asymptomatic infection at the time of laboratory confirmation has been reported<sup>[35]</sup>, however, the proportion of cases that remained asymptomatic in various studies ranges between 4% and 41%. A meta-analysis estimated the proportion of asymptomatic cases was 15%.<sup>[27]</sup> Similar viral loads have been reported in asymptomatic and symptomatic cases, indicating the potential for transmission from asymptomatic cases. However, while transmission from asymptomatic carriers has been reported the risk of transmission from pre-symptomatic or symptomatic patients is considered to be higher<sup>[27]</sup> and the WHO-China Joint Mission concluded that asymptomatic transmission does not appear to be a major driver of transmission.<sup>[14]</sup> A recent scientific brief from the WHO states that although transmission can occur from asymptomatic cases, the extent of this remains unclear.<sup>[36]</sup>

### Reproductive number

A review of published basic reproductive number (R0) estimates reported a range of 1.4 to 6.49, with a mean of 3.28 and a median of 2.79. A simulation of COVID-19 in New Zealand estimated an effective reproduction numbers of 1.8 prior to Alert Level 4 and 0.35 after moving to Alert Level 4.<sup>[37]</sup>

### Incubation period

Current estimates suggest a median incubation period of five to six days, with a range from two to 14 days<sup>[21, 25, 27, 38]</sup> which supports using 14 days as an operational definition for contact tracing and monitoring. These estimates are also supported by other modelling work and the WHO-China joint mission.<sup>[14, 39]</sup>

It should be noted that occasionally longer incubation periods have been reported<sup>[23, 25]</sup>.

### **Infectious period**

Viral RNA has been identified in respiratory tract specimens from 1–2 days before the onset of symptoms and for up to eight days in mild cases and for longer in more severe cases, peaking in the second week after infection.<sup>[20, 27, 40]</sup>

Viral RNA has been detected in upper respiratory tract specimens for prolonged periods following infection, including in cases who develop new or recurrent symptoms. However, replication competent virus has not been isolated from such cases and studies have identified no secondary infections amongst contacts of such cases.<sup>[41]</sup>

Risk of transmission peaks around symptom onset and in the following 5 days.<sup>[42]</sup> This is supported by a large contact tracing study of 100 cases and over 2700 close contacts in Taiwan found an overall secondary attack rate of 0.7%. The study found contacts with exclusively presymptomatic exposure were still at risk (attack rate 0.7%), that the attack rate was higher among household (4.6%) and non-household family (5.3%) contacts than in healthcare or other settings.<sup>[43]</sup> The study also found that high risk household and hospital contacts did not develop infection if there exposure was at least six days after the cases onset of symptoms.

### **Transmission**

Data from published epidemiology and virologic studies indicate that COVID-19 is primarily transmitted from symptomatic people to others who are in close contact through respiratory droplets, by direct contact with infected persons, or by contact with contaminated objects and surfaces (fomites).<sup>[7]</sup> Airborne spread is not believed to be a major driver of transmission (outside of aerosol generating procedures in healthcare).<sup>[44]</sup> Faecal-oral transmission does not appear to be a driver of transmission,<sup>[14]</sup> though gastrointestinal symptoms have been reported in in some cases.<sup>[22, 25, 39]</sup>

In China, human-to-human transmission occurred commonly within families, with a secondary attack rate in households of 3–10%. Extensive and comprehensive contact tracing has been undertaken in China with between 1% and 5% of identified contacts subsequently becoming laboratory confirmed cases. Testing at fever clinical and from routine ILI/SARI surveillance systems detected only very few COVID-19 cases.<sup>[14]</sup>

The secondary attack rate among household contacts in China was estimated to be 12.5 (95% CI 9.8–15.4) in close relatives and 17.1% (13.3–21.8) in those at the same residential address.<sup>[45]</sup>

As with SARS and MERS-CoV (where approximately 10% of the cases have been associated with super spreaders)<sup>[46]</sup> there is a potential for super spreaders for SARS-CoV-2. To date there have been reports from China of one case infecting 14 healthcare workers.<sup>[47, 48]</sup> A super-spreading event was reported at a choir practice in the US, with a secondary attack rate of 53.3 to 86.7%.<sup>[49]</sup>

Several outbreak investigations have found that COVID-19 transmission can be particularly effective in crowded, confined indoor spaces such as workplaces, churches, shopping centres and worker dormitories.<sup>[27]</sup>

A WHO scientific brief published on the 09 July concluded that further research is required to determine the role of airborne transmission in the absence of aerosol generating procedures.<sup>[36]</sup>

### **Immunity to SARS-CoV-2**

An ECDC review of the evidence to date has found that the IgM and IgG antibodies to SARS-CoV-2 develop between 6–15 days post disease onset with a median seroconversion time for total antibodies, IgM and then IgG were day-11, day-12 and day-14 post symptom onset, respectively. The presence of antibodies was detected in <40% among patients within 1 week from onset, and rapidly increased to 100% (total antibodies), 94.3% (IgM) and 79.8% (IgG) from day-15 after onset.<sup>[50]</sup>

For SARS-CoV-2 the longevity of the antibody response is unknown, however for other coronaviruses antibody responses are known to wane over time and re-infections with seasonal coronaviruses occur.<sup>[50]</sup>

Population based seroepidemiological studies have been undertaken across several EU/EEA Member States, all Member States currently have low levels of seropositivity and with current transmission patterns it is considered unlikely that population immunity levels, sufficient for indirect protection, will be reached ahead of the 2020/2021 winter.<sup>[50]</sup>

### **Impact of non-pharmaceutical interventions**

In response to the pandemic, many countries including New Zealand, have implemented unprecedented non-pharmaceutical interventions including stay at home policies, case isolation, closure of educational facilities, banning of mass gatherings and/or public events, and widescale social distancing measures including local and national lockdowns.<sup>[51]</sup> These non-pharmaceutical interventions have collectively been associated with a decrease in reported case numbers but the impact of individual interventions is unclear.

Several modelling studies have attempted to ascertain the impact of such interventions. The MRC Centre for Global Infectious Disease Analysis used a semi-mechanistic Bayesian hierarchical model to infer the impact of these interventions



across 11 European countries.<sup>[51]</sup> Authors found that the slowing growth in daily reported deaths in Italy was consistent with a significant impact of interventions implemented several weeks earlier, with the effective reproduction number dropping to around 1 at the time of lockdown, and that overall other countries have reduced their reproduction number, but with a high degree of uncertainty.<sup>[51]</sup>

A study of control strategies employed in Wuhan used an age and location specific transmission model to assess progression of the Wuhan outbreak under different scenarios of public health interventions. It found that changes to contact patterns through closures of workplaces and educational facilities, and other social distancing measures, are likely to have substantially delayed the epidemic peak and reduced the number of COVID-19 cases in Wuhan.<sup>[52]</sup> It also found that if restrictions are lifted in March 2020, a second peak of cases might occur in late August, with a further 2 month delay if restrictions were lifted in April.<sup>[52]</sup>

Following the removal or relaxation of control measures, several countries have experienced a resurgence in case reports.<sup>[53]</sup> For example in China, two months after the easing of the lockdown in Wuhan a spike in case numbers has led to the reinstatement of restrictions in parts of Beijing; in South Korea case reports have increased since restrictions were eased in May; in Tokyo, daily case numbers have begun to rise since the state of emergency was lifted and in Singapore, following extensive contact tracing and testing measures, a second wave of cases, largely affecting foreign workers living in dormitories arose.

Over recent weeks, since the easing of restrictions in states and territories in Australia, there has been a resurgence in cases, particularly in Victoria. In the week ending 29 July 2020, there were more than 2,500 cases reported in Victoria. As of 2 August 2020, this has resulted in further non-pharmaceutical interventions including curfews, restrictions on travel distances and limits on time out of the home, being put in place for metropolitan Melbourne, with slightly lesser, stay at home, restrictions remaining in place for regional Victoria.<sup>[54]</sup> Australia remain committed to a suppression strategy until there is a vaccine or effective treatment available, with a goal of no local community transmission.<sup>[55]</sup>

Various interventions were implemented in European countries (including stay-at-home policies and community and physical distancing measures). These approaches helped to successfully reduce transmission rates and as of 9 June 2020, the 14-day incidence declined in most countries in the EU/EEA and the UK, and overall it declined by 80% since a peak on 9 April.<sup>[54]</sup> As predicted, since the phasing out of interventions to varying degrees, some countries have seen an increase in positivity rates and deaths due to an increase in community transmission.<sup>[56]</sup> The ECDC considers the risk of further increases in incidence in these countries to be high and the probability of infection very high in the absence of a robust monitoring framework, expanded testing, a framework for contact tracing, ongoing implementation of sustainable non-pharmaceutical interventions and a strong risk communication strategy.<sup>[54]</sup> The ECDC considers the impact of rising COVID-19 incidence to be moderate, this assessment is based on likely increases in morbidity and mortality, the stress to health systems if increases are not rapidly controlled and the knowledge that non-pharmaceutical interventions can reduce transmission within two to three weeks.<sup>[56]</sup>

The ECDC assessment is that the probability of the risk of COVID-19 incidence rising to levels that require further stricter response measures, as a consequence of lifting/adjusting community level physical distancing measures ranges from moderate (with gradual reduction of measures, with only sporadic or cluster transmission and with monitoring, testing and contact tracing systems in place) to very high (if measures are phased out when there is still ongoing community transmission, and no appropriate monitoring systems and capacities for extensive testing and contact tracing are in place).<sup>[57]</sup>

It will be important to monitor the impact of the relaxation of non-pharmaceutical interventions both in New Zealand and in other countries. To minimise the risk of a resurgence in cases in New Zealand it will be important to continue to ensure robust border controls, surveillance, contact tracing and quarantine measures are in place.

### **Risk of importation to New Zealand**

As of 02 August 2020 there had been 17,660,523 confirmed cases of COVID-19 including 680,894 deaths reported to WHO.<sup>[6, 29]</sup> The WHO Region with the highest number of reported cases to date is the Americas (9,476,763), followed by Europe (3,375,535). Countries reporting over 50,000 new cases in the prior 24 hours to 02 August included the United States of America, Brazil, and India.

In New Zealand border restrictions have been in place for China since 02 February, were extended on 28 February to include travellers from Iran, and require travellers from a number of other countries with community transmission to self-isolate for 14 days on arrival.<sup>[58]</sup> From 15 March, all international arrivals, except from the Pacific Islands and Territories were required to self-isolate. Additional border measures came into effect on 26 March 2020, with only New Zealand residents and citizens (and their children and partners) still permitted to enter New Zealand. Residents and citizens returning to New Zealand are

required to remain in managed isolation or quarantine for at least 14 days after arrival and are required to undergo testing for COVID-19 at day 3 and day 12 of their managed isolation.<sup>[59]</sup> This testing and period of isolation has been assessed as reducing the risk of an infectious case being released into the community to a very low level.<sup>[60]</sup>

**Assessment of importation risk:** Even with the containment and borders measures in place in other countries and the border measures and containment measures currently in place in New Zealand, there remains a **HIGH** likelihood of importations from travellers to New Zealand, due to ongoing high rates of infection worldwide.

### Risk of further spread in New Zealand

There is a high awareness of COVID-19 within the health sector and amongst the general public in New Zealand.

New Zealand has in place a COVID-19 elimination strategy which includes border controls, robust case detection and surveillance systems, contact tracing and quarantine and community support of control measures.<sup>[61]</sup> Following a period of lockdown and strict social distancing, New Zealand is now under Alert Level 1 restrictions. Under Alert Level 1 people within New Zealand are able to travel and socialise more freely.<sup>[62]</sup>

New Zealand has a strong public health capability but would have limited capacity for community cluster control if there is sustained person-to-person transmission within New Zealand and particularly if driven by asymptomatic/mild clinical illness spread.

**Assessment of risk of transmission within New Zealand:** Given the current border and quarantine measures in place, the likelihood of transmission outside of isolation bubbles within quarantine facilities is **LOW-MODERATE**. The likelihood of transmission outside of quarantine facilities is currently **LOW**. This assessment assumes that cases in quarantine facilities are detected in a timely manner and that infection prevention and control measures are implemented promptly.

### Public health impact of COVID-19 in New Zealand:

The impact on the sector and the public from COVID-19 has been significant. The public health impact remains **HIGH** both for public health staff, the wider health sector and the community.

### Overall Public health risk:

Given the assessment of the likelihood of importation, the likelihood of transmission in New Zealand and the public health impact, the overall public health risk from this event remains **HIGH**. For the overall public health risk to reduce, there would need to be a demonstrable reduction in either or both the probability and/or impact of COVID-19 on the NZ population.

## REFERENCES

1. ECDC. 2011. *Operational guidance on rapid risk assessment methodology*. [https://www.ecdc.europa.eu/sites/portal/files/media/en/publications/Publications/1108\\_TED\\_Risk\\_Assessment\\_Methodology\\_Guidance.pdf](https://www.ecdc.europa.eu/sites/portal/files/media/en/publications/Publications/1108_TED_Risk_Assessment_Methodology_Guidance.pdf)
2. ECDC. 31 Jan 2020. *Risk assessment: Outbreak of acute respiratory syndrome associated with a novel coronavirus, China: first local transmission in the EU/EEA – third update*. <https://www.ecdc.europa.eu/en/publications-data/risk-assessment-outbreak-acute-respiratory-syndrome-associated-novel-1>
3. WHO. 11 Feb 2020. *WHO Director-General's remarks at the media briefing on 2019-nCoV on 11 February 2020*. <https://www.who.int/dg/speeches/detail/who-director-general-s-remarks-at-the-media-briefing-on-2019-ncov-on-11-february-2020>
4. WHO. 30 Jan 2020. *Statement on the second meeting of the International Health Regulations (2005) Emergency Committee regarding the outbreak of novel coronavirus (2019-nCoV)*. [https://www.who.int/news-room/detail/30-01-2020-statement-on-the-second-meeting-of-the-international-health-regulations-\(2005\)-emergency-committee-regarding-the-outbreak-of-novel-coronavirus-\(2019-ncov\)](https://www.who.int/news-room/detail/30-01-2020-statement-on-the-second-meeting-of-the-international-health-regulations-(2005)-emergency-committee-regarding-the-outbreak-of-novel-coronavirus-(2019-ncov))
5. World Health Organization. 2020. *WHO announces COVID19 outbreak a pandemic*. <http://www.euro.who.int/en/health-topics/health-emergencies/coronavirus-covid-19/news/news/2020/3/who-announces-covid-19-outbreak-a-pandemic>
6. WHO. 2 August 2020. *Coronavirus disease (COVID-19) Situation Report - 195*. [https://www.who.int/docs/default-source/coronaviruse/situation-reports/20200802-covid-19-sitrep-195.pdf?sfvrsn=5e5da0c5\\_2](https://www.who.int/docs/default-source/coronaviruse/situation-reports/20200802-covid-19-sitrep-195.pdf?sfvrsn=5e5da0c5_2)
7. World Health Organization, *Coronavirus disease 2019 (COVID-19) situation report 73*. 2020.
8. ESR. 02 August 2020. *NZ COVID-19 Dashboard* <https://nzcoviddashboard.esr.cri.nz/>
9. COVID-19 National Incident Room Surveillance Team. 2020. *COVID-19, Australia: Epidemiology Report 20*. [https://www1.health.gov.au/internet/main/publishing.nsf/Content/novel\\_coronavirus\\_2019\\_ncov\\_weekly\\_epidemiology\\_reports\\_australia\\_2020.htm](https://www1.health.gov.au/internet/main/publishing.nsf/Content/novel_coronavirus_2019_ncov_weekly_epidemiology_reports_australia_2020.htm)
10. CDC. 2020. *Coronavirus Disease 2019 (COVID-19) Situation Summary*. <https://www.cdc.gov/coronavirus/2019-nCoV/summary.html>
11. Ki M, Task Force for 2019-nCoV. 2020. Epidemiologic characteristics of early cases with 2019 novel coronavirus (2019-nCoV) disease in Republic of Korea. *Epidemiol Health*. <https://doi.org/10.4178/epih.e2020007>
12. Nishiura H, Kobayashi T, Yang Y, et al. 2020. The Rate of Underascertainment of Novel Coronavirus (2019-nCoV) Infection: Estimation Using Japanese Passengers Data on Evacuation Flights. *J Clin Med*; 9(2). <https://www.mdpi.com/2077-0383/9/2/419>
13. Rothe C, Schunk M, Sothmann P, et al. 2020. Transmission of 2019-nCoV Infection from an Asymptomatic Contact in Germany. *New England Journal of Medicine*. <https://www.nejm.org/doi/full/10.1056/NEJMc2001468>

14. WHO. 16–24 February 2020. *Report of the WHO-China Joint Mission on Coronavirus Disease 2019 (COVID-19)* <https://www.who.int/docs/default-source/coronaviruse/who-china-joint-mission-on-covid-19-final-report.pdf>
15. Wu Z, McGoogan JM. 2020. Characteristics of and important lessons from the coronavirus disease 2019 (COVID-19) outbreak in China: summary of a report of 72 314 cases from the Chinese Center for Disease Control and Prevention. *Jama*. <https://jamanetwork.com/journals/jama/fullarticle/2762130/>
16. Heymann D, Shindo N. 2020. COVID-19: what is next for public health? *The Lancet*. <https://www.thelancet.com/pbassets/Lancet/pdfs/S0140673620303743.pdf>
17. ECDC. 11 June 2020. *Clinical characteristics of COVID-19* <https://www.ecdc.europa.eu/en/covid-19/latest-evidence/clinical>
18. ISARIC (International Severe Acute Respiratory and Emerging Infections Consortium). 13 July 2020. *COVID-19 Report*. [https://media.tghn.org/medialibrary/2020/07/ISARIC\\_Data\\_Platform\\_COVID-19\\_Report\\_13JUL20.pdf](https://media.tghn.org/medialibrary/2020/07/ISARIC_Data_Platform_COVID-19_Report_13JUL20.pdf)
19. Giacomelli A, Pezzati L, Conti F, et al. 2020. Self-reported olfactory and taste disorders in SARS-CoV-2 patients: a cross-sectional study. *Clinical infectious diseases: an official publication of the Infectious Diseases Society of America*. <https://academic.oup.com/cid/article/71/15/889/5811989>
20. Zhou F, Yu T, Du R, et al. Clinical course and risk factors for mortality of adult inpatients with COVID-19 in Wuhan, China: a retrospective cohort study. *The Lancet*. [https://doi.org/10.1016/S0140-6736\(20\)30566-3](https://doi.org/10.1016/S0140-6736(20)30566-3)
21. Backer J, al. e. 2020. Incubation period of 2019 novel coronavirus (2019-nCoV) infections among travellers from Wuhan, China, 20–28 January 2020. *EuroSurveillance*. <https://www.eurosurveillance.org/content/10.2807/1560-7917.ES.2020.25.5.2000062>
22. Wang D, Hu B, Hu C, et al. 2020. Clinical Characteristics of 138 Hospitalized Patients With 2019 Novel Coronavirus–Infected Pneumonia in Wuhan, China. *JAMA*. <https://doi.org/10.1001/jama.2020.1585>
23. Guan W-j, Ni Z-y, Hu Y, et al. 2020. Clinical characteristics of 2019 novel coronavirus infection in China (pending peer review). *medRxiv*. <http://medrxiv.org/content/early/2020/02/09/2020.02.06.20020974.abstract>
24. Chen N, al. e. 2020. Epidemiological and clinical characteristics of 99 cases of 2019 novel coronavirus pneumonia in Wuhan, China: a descriptive study. *The Lancet*. <https://www.thelancet.com/journals/laninf/article/PIIS0140-6736%2820%2930211-7/fulltext>
25. Guan W-j, Ni Z-y, Hu Y, et al. 2020. Clinical characteristics of coronavirus disease 2019 in China. *New England Journal of Medicine*. <https://www.nejm.org/doi/full/10.1056/NEJMoa2002032>
26. Yang X, Yu Y, Xu J, et al. Clinical course and outcomes of critically ill patients with SARS-CoV-2 pneumonia in Wuhan, China: a single-centered, retrospective, observational study. *The Lancet Respiratory Medicine*. [https://doi.org/10.1016/S2213-2600\(20\)30079-5](https://doi.org/10.1016/S2213-2600(20)30079-5)
27. ECDC. 11 Jun 2020. *Epidemiology of COVID-19* <https://www.ecdc.europa.eu/en/covid-19/latest-evidence/epidemiology>
28. Spellberg B, Haddix M, Lee R, et al. 2020. Community Prevalence of SARS-CoV-2 Among Patients With Influenza-like Illnesses Presenting to a Los Angeles Medical Center in March 2020. *JAMA*. <https://doi.org/10.1001/jama.2020.4958>
29. WHO. 17 June 2020. *Coronavirus disease (COVID-19) Situation Report – 149* [https://www.who.int/docs/default-source/coronaviruse/situation-reports/20200617-covid-19-sitrep-149.pdf?sfvrsn=3b3137b0\\_4](https://www.who.int/docs/default-source/coronaviruse/situation-reports/20200617-covid-19-sitrep-149.pdf?sfvrsn=3b3137b0_4)
30. WHO. November 2019. *Middle East respiratory syndrome coronavirus (MERS-CoV)*. <http://applications.emro.who.int/docs/EMRPUB-CSR-241-2019-EN.pdf?ua=1&ua=1&ua=1>
31. Centre for Evidence Based Medicine. 2020. Global Covid-19 Case Fatality Rates: *Oxford Covid-19 evidence service*. <https://www.cebm.net/covid-19/global-covid-19-case-fatality-rates/>
32. Verity R, Okell LC, Dorigatti I, et al. 2020. Estimates of the severity of coronavirus disease 2019: a model-based analysis. *The Lancet Infectious Diseases*. [https://www.thelancet.com/journals/laninf/article/PIIS1473-3099\(20\)30243-7/fulltext](https://www.thelancet.com/journals/laninf/article/PIIS1473-3099(20)30243-7/fulltext)
33. Russell TW, Hellewell J, Jarvis CI, et al. 2020. Estimating the infection and case fatality ratio for coronavirus disease (COVID-19) using age-adjusted data from the outbreak on the Diamond Princess cruise ship, February 2020. *Eurosurveillance*; 25(12): 2000256. <https://www.eurosurveillance.org/content/10.2807/1560-7917.ES.2020.25.12.2000256>
34. CDC COVID-19 Response Team. 18 March 2020. Severe Outcomes Among Patients with Coronavirus Disease 2019 (COVID-19) – United States, February 12–March 16, 2020. *MMWR Morb Mortal Wkly Rep.*, [https://www.cdc.gov/mmwr/volumes/69/wr/mm6912e2.htm?s\\_cid=mm6912e2\\_e&deliveryName=USCDC\\_921-DM23064#suggestedcitation](https://www.cdc.gov/mmwr/volumes/69/wr/mm6912e2.htm?s_cid=mm6912e2_e&deliveryName=USCDC_921-DM23064#suggestedcitation)
35. Japan National Institute of Infectious Diseases. 21 Feb 2020. *Field Briefing: Diamond Princess COVID-19 Cases, 20 Feb Update*. <https://www.niid.go.jp/niid/en/2019-ncov-e/9417-covid-dp-fe-02.html>
36. WHO. 9 July 2020. *Scientific Brief: Transmission of SARS-CoV-2: implications for infection prevention precautions*. <https://www.who.int/news-room/commentaries/detail/transmission-of-sars-cov-2-implications-for-infection-prevention-precautions>
37. Binny L, Brower, Hendy, James, Parry, Plank, Steyn. 22 May 2020. Effective reproduction number for COVID-19 in Aotearoa New Zealand (pending formal peer review). <https://cpb-ap-se2.wpmucdn.com/blogs.auckland.ac.nz/dist/d/75/files/2020/05/Reproduction-number-NZ-draft-21May.pdf>
38. Li Q, Guan X, Wu P, et al. 2020. Early Transmission Dynamics in Wuhan, China, of Novel Coronavirus–Infected Pneumonia. *New England Journal of Medicine*. <https://www.nejm.org/doi/full/10.1056/NEJMoa2001316>
39. MRC Centre for Global Infectious Disease Analysis. 2020. *News - COVID-19*. <https://www.imperial.ac.uk/mrc-global-infectious-disease-analysis/news--wuhan-coronavirus/>
40. Pan Y, Zhang D, Yang P, et al. Viral load of SARS-CoV-2 in clinical samples. *The Lancet Infectious Diseases*. [https://doi.org/10.1016/S1473-3099\(20\)30113-4](https://doi.org/10.1016/S1473-3099(20)30113-4)
41. CDC. 22 July 2020. *Duration of Isolation and Precautions for Adults with COVID-19*. <https://www.cdc.gov/coronavirus/2019-ncov/hcp/duration-isolation.html>
42. WHO. 19 June 2020. *Criteria for releasing COVID-19 patients from isolation*. <https://www.who.int/news-room/commentaries/detail/criteria-for-releasing-covid-19-patients-from-isolation>

43. Cheng H-Y, Jian S-W, Liu D-P, et al. 2020. Contact Tracing Assessment of COVID-19 Transmission Dynamics in Taiwan and Risk at Different Exposure Periods Before and After Symptom Onset. *JAMA Internal Medicine*. <https://doi.org/10.1001/jamainternmed.2020.2020>
44. NZ Ministry of Health. 13 Feb 2020. *Novel coronavirus (COVID-19)*. <https://www.health.govt.nz/our-work/diseases-and-conditions/novel-coronavirus-covid-19>
45. Jing Q-L, Liu M-J, Zhang Z-B, et al. Household secondary attack rate of COVID-19 and associated determinants in Guangzhou, China: a retrospective cohort study. *The Lancet Infectious Diseases*. [https://doi.org/10.1016/S1473-3099\(20\)30471-0](https://doi.org/10.1016/S1473-3099(20)30471-0)
46. Gralinski L, Menachery V. 2020. Return of the Coronavirus: 2019-nCoV. *Viruses*. <https://www.mdpi.com/1999-4915/12/2/135/htm>
47. WHO. 21 Jan 2020. Novel Coronavirus Situation Report - 2. [https://www.who.int/docs/default-source/coronaviruse/situation-reports/20200122-sitrep-2-2019-ncov.pdf?sfvrsn=4d5bcbca\\_2](https://www.who.int/docs/default-source/coronaviruse/situation-reports/20200122-sitrep-2-2019-ncov.pdf?sfvrsn=4d5bcbca_2)
48. National Health Committee of the People's Republic of China. 12 Feb 2020. *Coronavirus – latest news*. [http://www.nhc.gov.cn/yjb/pqt/new\\_list.shtml](http://www.nhc.gov.cn/yjb/pqt/new_list.shtml)
49. Hamner D, Capron, Ross, Jordan, Lee, et. al. 15 May 2020. High SARS-CoV-2 Attack Rate Following Exposure at a Choir Practice — Skagit County, Washington, March 2020. *Morbidity and Mortality Weekly Report (MMWR)*; 69: 606–610. <https://www.cdc.gov/mmwr/volumes/69/wr/mm6919e6.htm#suggestedcitation>
50. ECDC. 11 June 2020. *Immune responses and immunity to SARS-CoV-2* <https://www.ecdc.europa.eu/en/covid-19/latest-evidence/immune-responses>
51. MRC Centre for Global Infectious Disease Analysis. 2020. *Report 13 – Estimating the number of infections and the impact of non-pharmaceutical interventions on COVID-19 in 11 European countries*. <https://www.imperial.ac.uk/mrc-global-infectious-disease-analysis/covid-19/report-13-europe-npi-impact/>
52. Prem K, Liu Y, Russell TW, et al. 2020. The effect of control strategies to reduce social mixing on outcomes of the COVID-19 epidemic in Wuhan, China: a modelling study. *The Lancet Public Health*. [https://www.thelancet.com/journals/lanpub/article/PIIS2468-2667\(20\)30073-6/fulltext](https://www.thelancet.com/journals/lanpub/article/PIIS2468-2667(20)30073-6/fulltext)
53. WHO. 08 August 2020. *WHO Coronavirus Disease (COVID-19) Dashboard (Accessed 06 August 2020)*. <https://covid19.who.int/>
54. Australian Government Department of Health. 21 July 2020. *COVID-19 in Victoria (accessed 03 August 2020)*. <https://www.health.gov.au/news/health-alerts/novel-coronavirus-2019-ncov-health-alert/coronavirus-covid-19-current-situation-and-case-numbers/covid-19-in-victoria>
55. Prime Minister of Australia. 24 July 2020. *National Cabinet Media Statement*. <https://www.pm.gov.au/media/national-cabinet-24jul20>
56. ECDC. 02 July 2020. *Resurgence of reported cases of COVID-19 in the EU/EEA, the UK and EU candidate and potential candidate countries* <https://www.ecdc.europa.eu/sites/default/files/documents/RRA-Resurgence-of-reported-cases-of-COVID-19-in-the-EU-EEA.pdf>
57. ECDC. 11 June 2020. *Coronavirus disease 2019 (COVID-19) in the EU/EEA and the UK – tenth update* <https://www.ecdc.europa.eu/sites/default/files/documents/RRA-COVID19-update10-2020-06-11.pdf>
58. NZ Ministry of Health. 1 March 2020. *Novel Coronavirus COVID-19 Sitrep 41*.
59. NZ Ministry of Health. 17 June 2020. *COVID-19 – Border controls* <https://www.health.govt.nz/our-work/diseases-and-conditions/covid-19-novel-coronavirus/covid-19-current-situation/covid-19-border-controls>
60. Steyn N, Binny R, Hendy S, et al. 16 July 2020. *Effect of New Zealand border controls on COVID-19 reincursion risk*. <https://www.tepunahamatatini.ac.nz/2020/07/16/effect-of-new-zealand-border-controls-on-covid-19-reincursion-risk/>
61. NZ Ministry of Health. 8 May 2020. *COVID-19: Elimination strategy for Aotearoa New Zealand* <https://www.health.govt.nz/our-work/diseases-and-conditions/covid-19-novel-coronavirus/covid-19-current-situation/covid-19-elimination-strategy-aotearoa-new-zealand>
62. New Zealand Government. 8 June 2020. *Alert system overview* <https://uniteforrecovery.govt.nz/covid-19/covid-19-alert-system/alert-system-overview/>