# Can we contain the COVID-19 outbreak with the same measures as for SARS?

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**The severe acute respiratory syndrome (SARS) outbreak in 2003 resulted in more than 8000 cases and 800 deaths. SARS was eventually contained by means of syndromic surveillance, prompt isolation of patients, strict enforcement of quarantine of all contacts, and in some areas top-down enforcement of community quarantine. By interrupting all human-to-human transmission, SARS was effectively eradicated. By contrast, by Feb 28, 2020, within a matter of 2 months since the beginning of the outbreak of coronavirus disease 2019 (COVID-19), more than 82 000 confirmed cases of COVID-19 have been reported with more than 2800 deaths. Although there are striking similarities between SARS and COVID-19, the differences in the virus characteristics will ultimately determine whether the same measures for SARS will also be successful for COVID-19. COVID-19 differs from SARS in terms of infectious period, transmissibility, clinical severity, and extent of community spread. Even if traditional public health measures are not able to fully contain the outbreak of COVID-19, they will still be effective in reducing peak incidence and global deaths. Exportations to other countries need not result in rapid large-scale outbreaks, if countries have the political will to rapidly implement countermeasures.**

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## Introduction

In November, 2002, the severe acute respiratory syndrome coronavirus (SARS-CoV) emerged in China causing global anxiety as the outbreak rapidly spread, and by July, 2003, had resulted in over 8000 cases in 26 countries. In December, 2019, a novel coronavirus, named SARS-CoV-2, emerged in Wuhan, China, and led to a rapidly spreading outbreak of coronavirus disease 2019 (COVID-19). By Jan 30, 2020, COVID-19 was declared a public health emergency of international concern. The similarities between SARS-CoV and SARS-CoV-2 are striking, not only in name. The whole genome of SARS-CoV-2 has a 86% similarity with SARS-CoV.[1] Both viruses share high degrees of homology to SARS-like coronaviruses isolated in bats, suggesting that bats are the probable origin of both SARS-CoV and SARS-CoV-2. Live animal markets selling multiple species of wild and domestic animals in proximity to large populations of densely housed humans are thought to be the source of both outbreaks. Even in terms of disease dynamics there are apparent similarities. The main transmission route is thought to be respiratory droplets, although viral shedding via faeces has also been reported for both viruses. The angiotensin-converting enzyme 2 (ACE2), found in the lower respiratory tract of humans, has been identified as the receptor used for cell entry for both SARS-CoV and SARS-CoV-2.[2,3] COVID-19 and SARS have a median incubation time of about 5 days. The mean serial interval of COVID-19 is 7·5 days (95% CI 5·3–19·0) and the initial estimate for the basic number ($R_0$) was 2·2 (95% CI 1·4–3·9),[4] similar to that reported for SARS (mean serial interval 8·4 days, and basic $R_0$ range 2·2–3·6 for serial intervals of 8–12 days).[5] Risk factors for severe disease outcomes are old age and comorbidities. The progression for patients with severe disease follows a similar pattern in both viruses, with progression to acute respiratory distress syndrome approximately 8–20 days after onset of first symptoms, whereby lung abnormalities on chest CT show greatest severity approximately 10 days after initial onset of symptoms.[6–9]

However, the similarities end here. The epidemic trajectory looks different. The SARS epidemic in 2003 reported 8098 cases with 774 deaths, and was eventually brought under control by July, 2003, in a matter of 8 months. Although 26 countries reported cases, the vast majority of cases were concentrated in five countries or regions: China, Taiwan, Hong Kong, Singapore, and

### Key messages

- There are many similarities between severe acute respiratory syndrome (SARS) and coronavirus disease 2019 (COVID-19) from the virus homology to the origin and transmission routes.
- SARS was effectively eradicated by implementing top-down draconic measures to halt all human-to-human transmission.
- Traditional public health measures used during SARS were successful and included active case detection, isolation of cases, contact tracing and quarantine of all contacts, social distancing, and community quarantine.
- Whether these measures will also be successful for COVID-19 will not depend on the similarities but the differences between SARS and COVID-19.
- Clear differences are emerging, such as in transmissibility and severity pyramids; COVID-19 has a higher transmissibility than SARS, and many more patients with COVID-19 rather than SARS have mild symptoms that contribute to spread because these patients are often missed and not isolated.
- Because of the extent of community spread, traditional public health measures might not be able to halt all human-to-human transmission, and we need to consider moving from containment to mitigation.

Toronto, Canada. SARS was eventually contained by means of syndromic surveillance, prompt isolation of patients, strict enforcement of quarantine of all contacts, and in some areas community-level quarantine. By interrupting all human-to-human transmission, SARS was effectively eradicated. By contrast, by Feb 28, 2020, within a matter of 2 months since the beginning of the outbreak, more than 82 000 confirmed cases of COVID-19 have been reported with more than 2800 deaths, mostly in China. Outside of China, 46 countries are reporting more than 3600 cases including at least 700 on several cruise ships.

Traditional public health measures were widely used to eradicate SARS. Can COVID-19 be controlled by these same measures? It is crucial to remember what measures were taken, and which lessons could be applicable to COVID-19.

## Extensive public health measures implemented during the SARS epidemic in 2003

In the absence of vaccines and specific treatment, the only available public health tools to control person-to-person transmittable diseases are isolation and quarantine, social distancing, and community containment measures.[10]

Isolation is the separation of ill people from non-infected people, and usually occurs in hospital settings, but could also be done at home for mild infections.[11] For isolation to be successful in preventing transmission, case detection should be early—ie, before the onset of viral shedding or at least before the onset of peak viral shedding. For SARS, viral loads peaked at 6–11 days after onset of illness for nasopharyngeal aspirates, enabling early isolation before transmission.[12] The number of secondary cases from an infected patient was clearly reduced if the infected patient was isolated within 4 days after onset of symptoms.[13] For SARS, a highly sensitive case definition was used with a focus on fever or respiratory symptoms, and an epidemiological link (contact or travel history). All suspected patients were isolated until SARS was ruled out. Implementing optimal isolation by itself was modelled to be more cost-effective than implementing suboptimal isolation and quarantine together.[14] Secondary household transmission was low in Singapore (6·2%), indicative of rapid detection and isolation of patients. Similarly, in Toronto, secondary attack rate in households was 10%, with a linear association between secondary attack rate and the time that the index patient spent at home after symptom onset.[15] In Singapore, health-care-associated transmission accounted for more than 90% of all cases.[16] Once full measures were in place, almost all patients were promptly isolated before secondary transmission had occurred. The outbreak in Singapore was propagated by five superspreading events,[16] including three superspreading events as a result of atypical clinical manifestations of SARS.[17]

Quarantine involves movement restriction, ideally combined with medical observation during the quarantine period, of close contacts of infected patients during the incubation period.[18] The premise for successful quarantine is prompt and comprehensive contact tracing of each and every confirmed patient. Quarantine can take place at home or in designated places such as hotels, and both of these options were used during the SARS epidemic. Quarantined contacts had to record their temperatures, and were visited or telephoned daily by a member of the public health-care team. If the contact developed symptoms, they were investigated at a designated health-care facility. The principle is that if the person under quarantine developed illness, that person would not have any close contacts to spread the disease, effectively reducing the $R_0$ of the outbreak to less than 1. As an example of the magnitude of efforts taken, Toronto Public Health investigated 2132 potential cases of SARS and identified 23 103 contacts as requiring quarantine.[19] Legally enforceable quarantine orders were issued to contacts. Police made spot checks in Hong Kong whereas video cameras were installed at the home of each contact in Singapore.[16,20]

Once it is no longer feasible to identify all infectious individuals and their contacts in the attempt to slow the spread of disease, a possible next step is to apply community-wide containment measures. Community-wide containment is an intervention that is applied to an entire community, city, or region, designed to reduce personal interactions.[10] These interventions range from measures to encourage personal responsibility to identify disease, increase social distancing among community members including cancellation of public gatherings, and finally implement community quarantine.[11] Enforcement of community-wide containment measures is far more complex than isolation or quarantine because of the larger number of people involved. China best exemplified this large-scale quarantine by declaring epidemic zones and placing people under collective quarantine in villages, cities, or institutions.[21] In April 2003, the Chinese authorities gained full control of all activities to combat SARS, with guidelines and control measures that were national, unambiguous, rational, and widely followed, under central guidance. The stringent control measures included school closures and closures of all universities and public places, as well as the cancellation of the public holiday in May. Immediately, the $R_0$ decreased greatly and consistently.[22] In May, 2003, China locked down Beijing and closed more than 3500 public places in an effort to curb community spread.

Singapore became the so-called country of thermometers: temperature monitoring was made mandatory in schools and temperature screening was instituted at entry to public buildings. Case detection was further improved by the opening of hundreds of fever clinics and use of the mass media to encourage people to check for fever several times a day. Citizens with higher degrees of anxiety, better knowledge about SARS, and greater risk perceptions than average were more likely to take comprehensive precautionary measures against the infection.[23] In Hong Kong, 49% of the patients with SARS were in clinics, hospitals, and elderly or nursing homes. The Amoy Gardens cluster accounted for another 18·8% of cases; these affected areas were put on community quarantine.[24] Awareness about SARS was very high, and there was an extraordinarily high willingness (90% of respondents in a psychobehavioural study in Singapore and Hong Kong) to be quarantined if deemed necessary.[23] There was a strong political will in all affected countries with a top-down approach to enforce all public health measures in a short timeframe. In mainland China, the strong political commitment with a centrally coordinated response was considered the most important factor in the control of SARS.[22]

Hospital-based measures included isolation rooms with barrier nursing techniques, strict enforcement of personal protective equipment for staff, and restriction of visitors and movement of staff. Negative pressure rooms were not used, or only used when available. Infection control precautions were enhanced in all hospitals, and included the provision of separate triage facilities for patients with fever or respiratory symptoms. In Toronto and Singapore, workers were required to use gloves, gowns, eye protection, and N95 respirators for all contact with all patients, regardless of whether SARS was suspected or not.[19] To reduce within-hospital spread, hospitals banned all visitors to patients with SARS except on compassionate grounds.[19] Health-care workers or visitors exposed to facilities where SARS transmission had occurred were not permitted to enter non-SARS areas.[25] In Singapore, temperature screening was mandated twice daily for all health-care workers.[26] Health-care workers who developed a fever had to report to a designated health-care facility, and were isolated until SARS was ruled out. To accommodate the large number of patients with SARS (both probable and suspect), Beijing rapidly constructed the 1000-bed Xiaotangshan hospital within a week, which admitted a seventh of SARS patients in the country within 2 months.

### Prevention of global spread

Following the WHO global alert, and a stronger emergency travel advisory issued by WHO on March 15, 2003, almost all countries with imported cases were able to either prevent any further transmission or keep the number of additional cases small. Exit screening via thermal scanners was done for all departing passengers at all airports of affected countries. Many countries also implemented entry screening for all passengers arriving from affected areas. After all these measures were implemented, new imported cases of SARS did not trigger new outbreaks as systems were in place to identify and isolate them early.[27] No travel bans were implemented at any time, but travel advisories to avoid non-essential travel to countries affected by SARS were issued by several governments. The psychological effects of SARS, coupled with travel restrictions imposed by various national and international authorities, resulted in a major economic loss for the airline industry and world economy in 2003, far beyond the main areas affected by SARS.[28]

## What is different in 2020 compared with 2003?

17 years later, we can draw upon the lessons learnt from SARS. The global community is much better prepared now, with many capacity-building initiatives including those under the WHO's International Health Regulations (2005). Indeed, the time interval from the first case description to the virus sequencing and the availability of diagnostic assays was much faster for COVID-19 than for SARS, and diagnostic tests were available globally within 2 weeks of reports of cases from China. Organisations such as the Global Outbreak Alert and Response Network, the Coalition for Epidemic Preparedness Innovations, and the Global Research Collaboration For Infectious Disease Preparedness, supported by the WHO Research Blueprint and its Global Coordinating Mechanism, were able to accelerate the outbreak response and rapidly initiate technical platforms for the development of vaccines and therapeutics.[29] Standardised data collection tools were distributed and used within a matter of weeks, and the first clinical trials for therapeutic interventions was initiated in January.[30] China has higher medical standards, a better educated health-care workforce, and more technical and scientific expertise now than in 2003. China's current response contains much more transparency and decisive action, which was initiated much earlier in the current outbreak than in the 2003 outbreak.[31]

So why have the case numbers of COVID-19 already surpassed those of SARS by Jan 30, 2020?

There are several explanations. First, the situation is different. Wuhan, the epicentre of COVID-19, combines multiple elements that make containment challenging. As the largest city (>11 million) in central China, Wuhan is a major transport hub and centre for industry and commerce, home to the largest train station, biggest airport, and largest deep-water port in central China.[32] China's outward travel has more than doubled in the past decade, and its urban population densities possibly even tripled. The proximity of people in residential housing, during commute, and in work environments in a megacity such as Wuhan amplifies person-to-person transmission. The sheer population size is the single biggest challenge. Hospitals were initially overwhelmed by the number of patients, and many patients were not hospitalised because of a shortage of hospital beds, thereby contributing to seeding in the community. A new hospital was built within 10 days. A massive banquet with 40 000 guests took place just before the lockdown, further exacerbating community spread. Worse, in the days just before Wuhan was put under lockdown, more than 5 million people (many of whom might have been incubating the virus) had travelled out because of the upcoming Spring Festival, thus spreading COVID-19 to other provinces in China. The high connectivity of Wuhan to international airports further facilitated rapid spread to cities and countries with high air passenger volumes from China, such as Singapore, Japan, and Thailand.[33,34]

A second explanation might be that the infectious period is different. Isolation was effective for SARS because peak viral shedding occurred after patients were already quite ill with respiratory symptoms and could be easily identified. Although asymptomatic or mildly symptomatic patients have been reported for SARS,[35] no known transmission occurred from these patients. By contrast, preliminary evidence from exported COVID-19 cases suggest that transmission during the early phase of illness also seems to contribute to overall transmission;[36,37] therefore, isolation of more severely ill patients at the time of presentation to health-care facilities will be too late. The effectiveness of isolation and contact tracing methods depends on the proportion of transmission that occurs before symptom onset. Pre-symptomatic transmission will also make temperature screening less effective.[38]

A third explanation could be that the transmissibility might be higher for COVID-19 than for SARS. $R_0$ is a central concept in infectious disease epidemiology, indicating the risk of an infectious agent with respect to its epidemic potential. A recent review (published in February, 2020) found the average $R_0$ of COVID-19 to be 3·28 and median $R_0$ to be 2·79, higher than that of SARS, although more accurate estimates can only be ascertained when the epidemic stablises.[39] The speed of spread of COVID-19—from the first documented case in early December, 2019, to 80 000 cases by the end of February, 2020, despite massive containment efforts—is certainly much faster than that reported for SARS between November, 2002, and March, 2003, before any forms of containment were even instituted. The high attack rates on the cruise ship Diamond Princess in Japan, with more than 700 on board infected out of approximately 3700 cruise ship passengers and crew members by Feb 28, 2020, despite public health measures, suggest a very high transmissibility.[40]

A fourth explanation is that the clinical spectrum is different. China's initial case definition was focused on pneumonia, and initial case fatality rates (CFR) were reported at about 10% on the basis of this narrow case definition.[6] However, as the epidemic unfolds, it has become apparent that mild cases are common in COVID-19. Patients with mild disease manifestations will be missed even if a more sensitive surveillance system were in place, and these patients might spread the disease silently, similar to influenza. On Feb 18, 2020, the Chinese Center for Disease Control and Prevention published their data of the first 72 314 patients including 44 672 patients with confirmed COVID-19.[41] As many as 81% of the patients with confirmed COVID-19 were reported to have a mild disease or less severe forms of pneumonia, whereas 13·8% had a severe condition and 4·7% were critically ill. The study also noted that nearly half (49%) of the critically ill patients have died. Of the patients from the Diamond Princess cruise ship, which provides a captive cohort to study the virus, more than 10% were asymptomatic upon diagnosis. Estimating CFRs remains elusive, as many patients are still in the early stages of disease, and more fatalities could occur given that death seems to occur 2–4 weeks after onset of symptoms.[6,7] The current estimate by the Chinese Center for Disease Control and Prevention is a CFR of 2·3%, with increasing CFRs for patients with advanced age or comorbidities. However, the report also shows that CFRs vary greatly between Wuhan and other provinces in China; therefore some uncertainty remains around CFRs. With already more than 3600 cases imported into or acquired in other countries (or on cruise ships), more information on the full spectrum of disease and a better estimate of the CFR should be available in the next few weeks. Of note is that even if the CFR of COVID-19 (possibly <2%) is far lower than that of SARS (10%), this is not reassuring, as a highly transmissible disease with low CFR will result in many more cases, and therefore also ultimately more deaths than SARS.

A fifth explanation is that community spread is more prominent. Whereas SARS was mainly an outbreak propagated within hospitals, widespread community transmission is already evident for COVID-19. By Feb 28, 2020, more than 82 000 cases had been reported. Some models indicate that several hundred thousand infections might already exist in China. Consequently, there will be more unknown contacts than known contacts in the community, which means that many contacts who will subsequently develop an infection are not quarantined and under proper medical observation. Hence, China decided to enforce the most drastic of all classic public health measures: community containment with social distancing, community use of facemasks, and a lockdown of Wuhan's public transportation, including buses, trains, ferries, and airport. As the community-based outbreak spread, the lockdown was extended to more than 60 million residents in more than 20 cities by Jan 30, 2020. China has essentially issued the largest quarantine in history to prevent its spread to the rest of the world. By Jan 30, 2020, 113 579 close contacts have been tracked and a total of 102 427 people were receiving medical observation. This approach is an unprecedented gigantic effort that surpasses all efforts done during SARS.

## Conclusions

The gigantic efforts come at a cost to travel and trade, to China's economy and beyond, let alone the mental health of millions of people under lockdown. These sacrifices are being made because the memories of SARS fuel hope that containment is feasible. Whether these rigorous measures will indeed result in the same success as for SARS depends on the extent of transmissibility of subclinical cases (asymptomatic or mildly symptomatic), including the timing of peak viral shedding during the course of disease, as well as on the role of fomites and other environmental contamination in propagating transmission.

The answers to these questions will determine the success. Until those answers are known, the political and medical community needs to persist with containment efforts with the tools that are available at hand for the time being. China should be commended for its political will in implementing what might appear to be extreme measures. Undoubtedly, no other country could enact what China is currently doing. The daily decline in new cases by mid-February suggests that China is on the right path, showing that containment could be feasible. Other countries should be aware and reduce the spread of COVID-19. What is already known is that exportations to other countries need not result in rapid large-scale outbreaks, if the countries have the political will to rapidly implement early case detection, prompt isolation of ill people, comprehensive contact tracing, and immediate quarantine of all contacts. If this approach is not feasible because of widespread community transmission, then community quarantine is also needed with rigorous implementation of social distancing.

Containment of COVID-19 should remain the focus at the moment. The short-term cost of containment will be far lower than the long-term cost of non-containment. However, closures of institutions and public places, and restrictions in travel and trade, cannot be maintained indefinitely. Countries have to face the reality that individual-case containment might not be possible in the long run, and there might be the need to move from containment to mitigation, balancing the costs and benefits of public health measures. Even if our public health measures are not able to fully contain the spread of COVID-19 because of the virus characteristics, they will still be effective in delaying the onset of widespread community transmission, reducing peak incidence and its impact on public services, and decreasing the overall attack rate. In addition, minimising the size of the outbreak or suppressing its peak can reduce global deaths by providing health systems with the opportunity to scale up and respond, and to slow down the global spread until effective vaccines become available.

### Contributors

AWS initiated this Personal View and wrote the first draft. All authors contributed equally to the final manuscript.

### Declaration of interests

We declare no competing interests.

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