25 YEARS FOR BETTER HEALTH SYSTEMS

The COVID-19 epidemic in Georgia
Projections and Policy Options

27 March 2020

Acknowledgments

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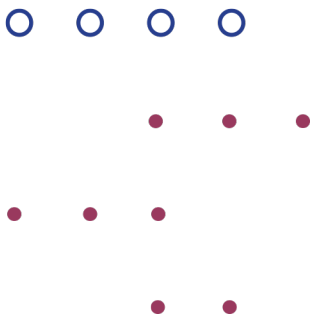
The document is prepared in Georgian and English languages. Annexes are provided in English only.



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Introduction

COVID-19 epidemic in Georgia

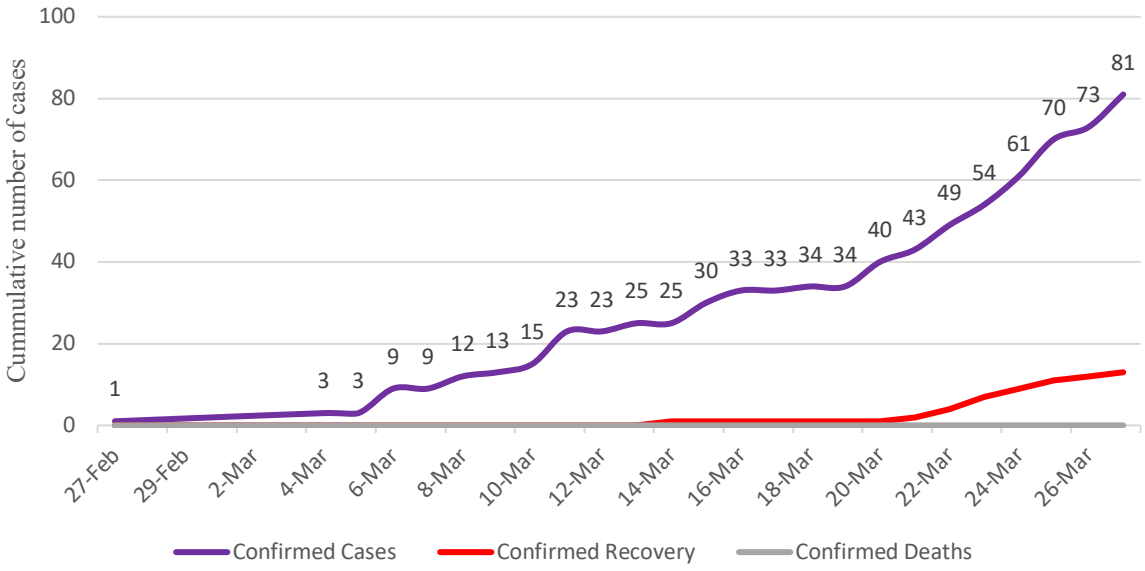
The first case of coronavirus (COVID-19) in Georgia was reported on February 27, 2020. By March 27, the number of confirmed cases in Georgia reached 81. Case trends are shown in Figure 1.

Georgia, March 27, 2020

- Suspected new cases: 83
- Confirmed cases: 81
- Recovered cases: 13
- Hospitalised cases: 247
- Quarantined cases: 4505

The epidemiological situation after three weeks of diagnosing the first case of coronavirus clearly indicates that the country implemented timely and progressive containment measures. These include the screening of travelers coming to Georgia from countries with a high prevalence of the viral infection, COVID 19 testing, contact tracing, the introduction of quarantine and self-isolation rules, decision on suspending international flights, closure of educational institutions, appeal to the employed to switch to online work, restriction of mass gatherings, partial restriction on public transportation, development of surveillance measures, inter alia elaboration and adoption of new protocols, engagement in active communication with the public and so on.

Figure 1. COVID-19 cases in Georgia as of 27 March, 2020



According to the World Health Organization's (WHO) classification, Georgia is currently in the phase of the "Cluster of Cases" (scenario 3 of the epidemic),` when most of the cases of local transmission are linked to chains of transmission (WHO, 2020b). The next stage of the epidemic is a "Community Transmission," during which it is no longer possible to identify the chain of transmission.

Trends in the spread of the epidemic in different countries

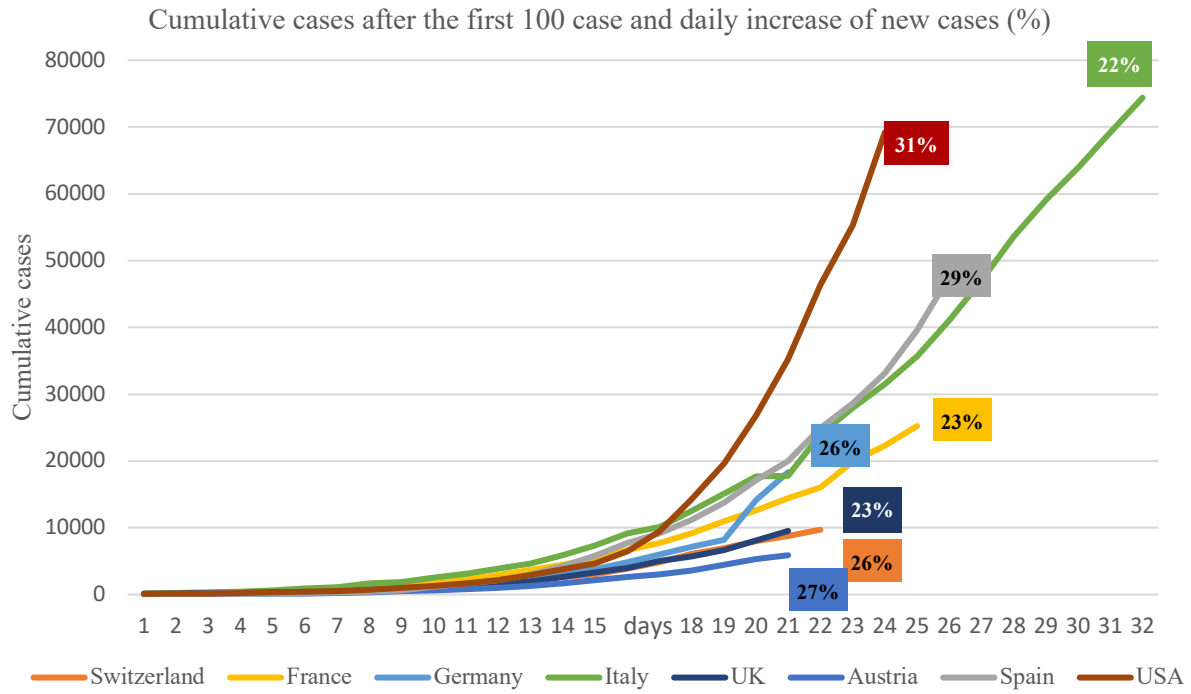
How many days does it take to reach the stage of the Community Transmission of the epidemic in a country? The answer to the question varies by country according to measures taken in response to the

epidemic. It took from 11 to 37 days to the European countries and the USA to identify the first 100 confirmed cases.

However, it is noteworthy that the countries with the passive response (Italy, France, Germany, Great Britain, Switzerland, Spain, Austria, and the USA) had 500 cases in 3-4 days after the first 100 cases. While Germany, the UK, and Switzerland are represented by lower curves on the chart below, all of these countries experience a 25-32% daily increase in new cases of COVID-19 (ECDC, 2020c).

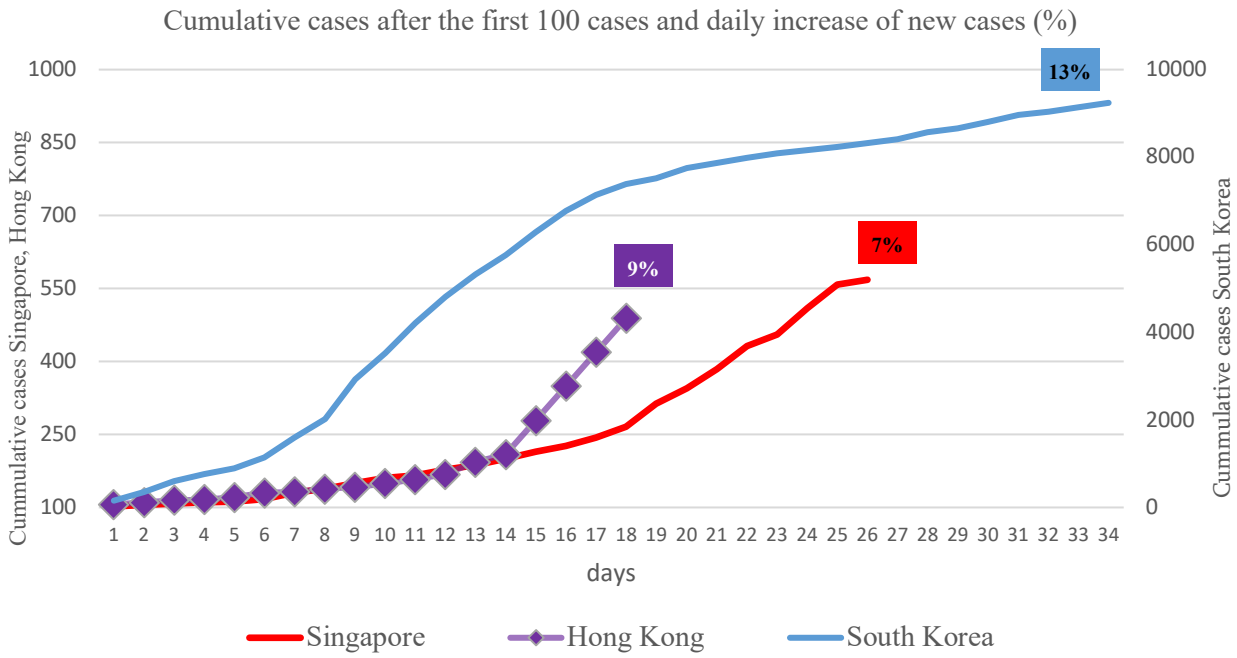
The growth rate of the epidemic in Estonia is 11%, in Latvia – 12%, and in Lithuania, which suppressed 100 case benchmark 5 days ago, cases increase with 19% per day. Indeed, such comparisons should take into account the size of a country and its population density.

Figure 2. Increase in the number of COVID-19 cases (Italy, Germany, UK, France, Spain, Switzerland, Austria, and USA)



Asian countries that took tough and timely measures to combat the epidemic, such as South Korea, Hong Kong and Singapore experienced the first 100 cases after 20, 36, 36 and 66 days, respectively. As for the increase of cases from 100 to 500, South Korea hit this mark in two days. It took 14 days to double the number of cases in Singapore and Hong Kong (ECDC, 2020c). The rapid growth rate of the epidemic in South Korea is linked to an intensive contact investigation and extensive testing after the initial outbreak of the epidemic. Owing to that, the number of reported cases is likely to be as close to the actual spread of the infection as possible (Our World Data, 2020).

Figure 3. Increase in the number of COVID-19 cases in selected Asian countries



Considering the characteristics of the epidemic growth rate in the aforementioned countries, we can assume that the COVID-19 growth rate in Georgia lies between average rates of Europe / USA and Asian countries. With this assumption, it is also likely that the first 100 cases in Georgia will be reached on the 30-35th day after the start of the epidemic.

Projections of COVID-19 epidemic in Georgia

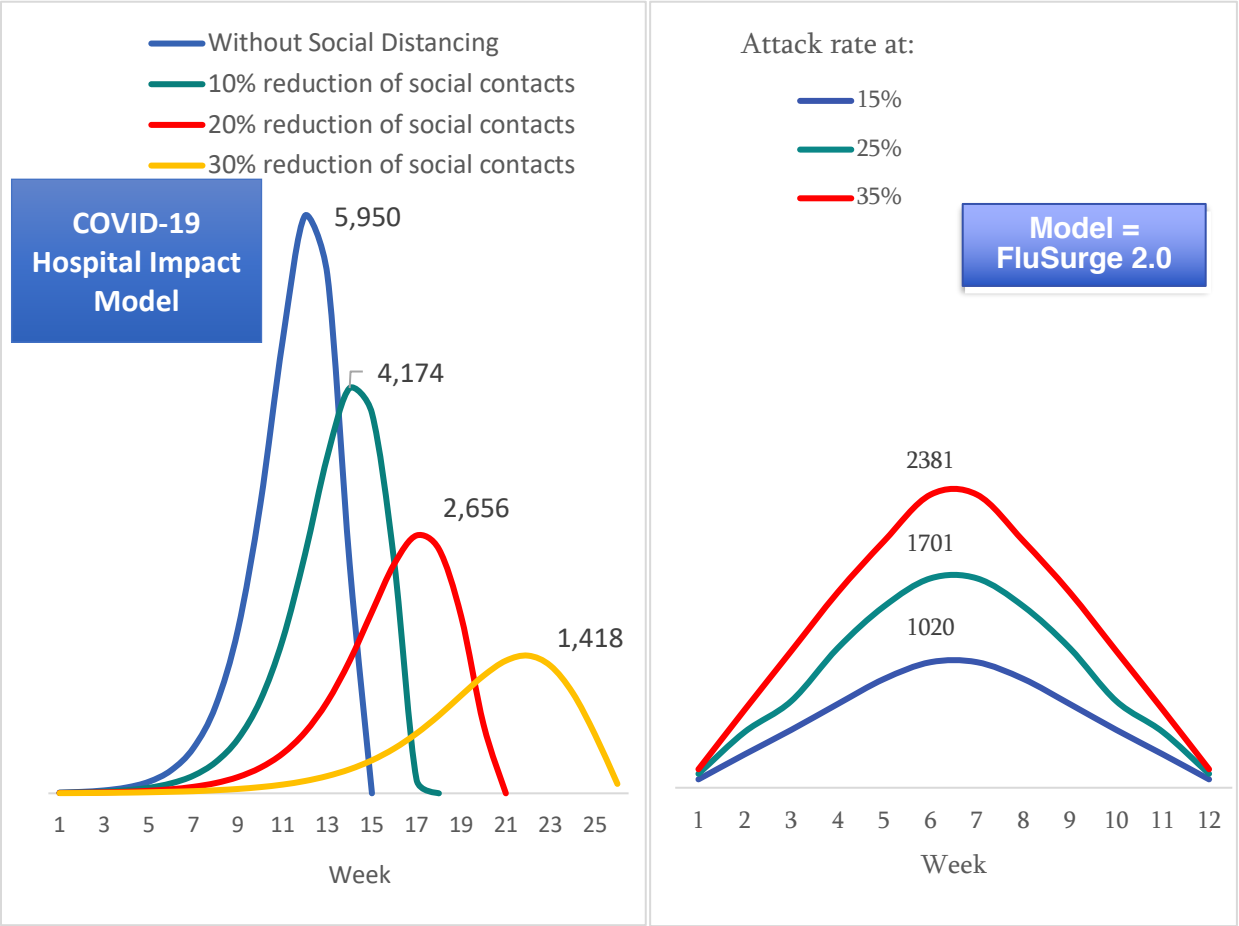
In order to assess the preparedness of the health system for the COVID-19 epidemic, Curatio International Foundation conducted a modeling exercise for which it used two different tools:

1. **COVID-19 Hospital Impact Model for Epidemics,** which is developed in Pennsylvania by Penn Medicine Predictive Healthcare Team specifically for this epidemic https://penn-chime.phl.io/
2. **FluSurge2.0,** developed by the US Centers for Disease Control and Prevention for Pandemic Influenza https://www.cdc.gov/flu/pandemic-resources/tools/flusurge.ht

The first model (**COVID-19 Hospital Impact Model for Epidemics**) is based on several assumptions related to the characteristics of the coronavirus case management among inpatients. It allows determining the impact of different levels of "social distancing" on the level of virus-induced admissions. The second model is used to assess the effects of pandemic influenza, and it is not based on the epidemiological characteristics of COVID-19.

Below we present the comparison of the results obtained with both models (see Figure 4.).
Calculations were done on March 19th 2020.

Figure 4. Comparison of hospitalization by different models



Key findings of the projections

- Social distancing is crucial to containing the epidemic (Anderson, Heesterbeek, Klinkenberg, & Hollingsworth, 2020);
- Without social distancing, the peak of the epidemic will be reached quickly, the number of new cases requiring hospital care in the peak week will be 5,950, and the country's health system cannot withstand this situation.
- The use of social distancing measures that reduce the number of contacts by 10% prolongs the epidemic, allows reaching the peak of the epidemic on the 14th week, and reduces the number of new cases requiring hospital care to 4,174.
- With the reduction of the number of contacts by 20%, the peak of the epidemic will be reached in the 17th week, and new hospitalizations will drop to 2,656, further reducing the burden on the hospital sector.
- With the reduction of the number of contacts by 30%, it is possible to reach the peak of the epidemic in the 22nd week and to reduce new hospitalizations to 1,418.
- Projections obtained using the **COVID-19 Hospital Impact model** significantly exceed those generated with the FluSurge 2.0 model for a 12-week outbreak.

- During the use of these projections, one should take into account that multiple assumptions are used in the estimations.

Need for evidence - how to manage the epidemic effectively?

Since the epidemic is unknown to the world, the experience of countries that have taken successful steps and delayed the peak of the epidemic is essential.

Presently, such countries include Singapore, Hong Kong and South Korea. Based on the summarized evidence, we identified set of measures for effective response to the epidemic.

The evidence synthesis product was shared with the MoILHSA and the Prime Minister's office on March 23rd 2020.

It is important to note that the information is updated on a daily basis, and therefore the evidence is accumulating gradually. Hence, continuous monitoring of the experience of other countries would be helpful.

Measures and actions for effective management of the epidemic

National planning / coordination

- **Develop and continuously update the action plan** based on the refinement of data on health service capacities (the number of free or yet to be freed general and critical care beds, ventilators) and the comparative analysis of the expected demand depending on the status of the epidemic. (ECDC, 2020b, WHO, 2020b; Remuzzi & Remuzzi, 2020; Legido-Quigley et al., 2020; Bicker, 2020).
- On the one hand, the **strengthening of quarantine points** at the country's borders to prevent new imported cases and, on the other hand, the reduction of community transmission by **social distancing**, which, together with other public health actions, is vital to slow the speed of the epidemic (Ferguson et al., 2020). Although the prolonged use of these methods is difficult and presents economic challenges, they are critical to **prevent the overwhelming of the health care system.** At the same time, it is crucial to monitor the situation regularly (Quilty, Clifford, Cmmid nCoV Working Group, Flasche, & Eggo, 2020; Barron, 2020; Wong et al., 2020; Wang et al., 2020; Cowling & Lim, 2020; WHO, 2020c; (Anderson, Heesterbeek, Klinkenberg, & Hollingsworth, 2020; Ferguson et al., 2020).
- Due to the uncertain effectiveness of social distancing, it is difficult to predict how long the epidemic peak will be postponed and how much the peak level will be reduced. It is therefore advisable that the health care preparedness planning follow **the relatively pessimistic scenario** (curve for 10% reduction of contacts). (Ferguson et al., 2020).
- Continue the ongoing, transparent, and coordinated **communication with the population.** (WHO, 2020d; WHO, 2020b; Barron, 2020).

Public health actions

- **Continue contact detection and isolation** on the current stage of the epidemic that will facilitate containing the epidemic. (Hellewell et al., 2020, Anderson et al., 2020; Shim, Tariq, Choi, Lee, & Chowell, 2020).
- **Improve monitoring of the compliance with self-isolation and quarantine** rules utilizing new technologies, e.g., through the use of electronic wristbands providing information on people's movement in real-time. (Hellewell et al., 2020; Saiidi, 2020)
- Formulate communication messages and use different communication channels (e.g., social media) for a **proper, coordinated communication campaign. The role of social media** is especially important during prolonged and extensive measures of containment for improving compliance and avoiding the spread of false information and expectations. epidemic (WHO, 2020b; Barron, 2020)
- Define the specific objectives of rapid testing, develop and introduce algorithm for the medical facilities with the involvement of a private sector. (WHO, 2020d; Chadwick, n.d.; Kwon, Ko, Shin, Sung, & Kim, 2020; FDA, 2020)

- Focus on high-priority actions taking into account available resources, including the rational use of confirmatory tests. (ECDC, 2020)

Health system measures

- Differentiation of hospitals for managing cases of different severity. (ECDC, 2020b).
- **Triage of patients** to reduce referrals to medical facilities as much as possible (Cao et al., 2020; Parodi, Jewkes, Cha, & Park, n.d.).
- Development of a triage protocol to identify the risk of COVID-19 morbidity and, if any, (including mild cases) to refer the patient to the appropriate facility. (Bicker, 2020; Cao et al., 2020)
    - Develop a home care protocol which is essential to consider when a case referral is delayed, to prevent the transmission of the disease within a household;
    - Provide triage and home care protocol to hotline operators, 112 ambulance teams, and family and rural doctors;
    - Arrange for **virtual consultations** by family doctors (it can be done in big cities) with the active engagement of the private sector. The consultation should be based on the established protocols for the identification and triage of COVID-19 cases.
- Announce the procedure of seeking medical service in the communication messages. Use mobile text messages for these purposes
- Development / adoption of COVID-19 **clinical case management guidelines** based on the latest recommendations (CDC, 2020; WHO, 2020a)
- **Replacement of medical facilities used as quarantine sites** with alternative non-medical facilities to accommodate close contacts and use the medical facilities for admitting mildly ill patients to prevent the transmission of infection from them to their household members (ECDC, 2020b; WHO, 2020e);
- Expand surveillance for atypical pneumonia to detect COVID-19 at the primary and hospital care levels across the country, continue surveillance for COVID-19 cases at the sentinel sites (WHO, 2020e);
- **Rearrangement of service delivery to the beneficiaries of health programs** to ensure safety and continuity care for certain groups of population (e.g., immunization, TB, subsidies for medicines to treat chronic diseases and other programs).

Infection Prevention and Control in medical facilities

- Development of preparedness plans by health facilities (including hospitals that do not participate in the management of COVID-19, and primary care providers) to include items described below (Liu, Li, & Feng, 2020)
- Implementation of a patient triage protocol at the facility (e.g., protocol used in China

Annex 3)

- Observance of the medical facility's standard infection control procedures by the patients (WHO, 2020c)

- Develop a personalized work plan for staff (physicians, junior doctors, nurses, attendants) per the following principles (Liew, Siow, Maclaren, & See, 2020) (see Annex 3):
  - → Develop a 14/14-day schedule to stay at the medical facility and wash-out period at home (14 days on-shift / rest at the hospital, followed by 14 days washout period at home with the observance of self-isolation rules (monitoring of body temperature, etc.). Provide necessary infrastructure and food supplies to respective facilities to sustain such schedule;
  - → Develop a shift staff replacement plan in case of a staff absence.
  - → Develop criteria for letting the staff access the facility.
  - → Develop a plan to mobilize additional staff, indicating their names and work hours.
- Staff safety
  - → Provision of personal protective equipment and staff training in line with the latest recommendations (ECDC, 2020a; WHO, 2020c; CDC (CDC, 2020) first of all to facilities taking care of COVID-19 cases and also to other large hospitals.
  - → Allocation of appropriate places at the facility for wearing and removing of PPE.
  - → Introduction of benefits (e.g., leave, transfer to a less risky department, etc.) for personnel at higher health risks (aged or those suffering from chronic illnesses).
- Performance of aerosol-generating procedures in accordance with the safety principles (WHO, 2020a; CDC, 2020; Cheng et al., 2020)
  - E.g., avoidance of non-invasive ventilation and high-pressure nasal cannula oxygenation when negative pressure wards are not available;
  - E.g., intubation or respiratory tract cleaning with great caution, differentiation of staff when such procedures are performed.

Evidence Synthesis

Synthesis

All four counties Hong Kong and Singapore were especially vulnerable to COVID-19 due to their proximity to and close ties to China mainland, where the global epidemic started. Owing to the experience from the previous epidemics (2003 SARS and 2009 pandemic influenza), the countries were well prepared to respond with early interventions.

Hong Kong deployed pervasive measures to encourage social distancing with the early quarantine of contacts and other community response activities. Schools and working places were closed, intensified testing was introduced. The country applied innovative technologies in contact tracing, namely the use of wristbands.

South Korea applied a different approach. In response to the widespread transmission of local cases stemming from several clusters, the country initiated active contact tracing, early identification of infectious individuals, and their isolation. South Korea was the only country that launched mass testing to the level of the epidemic. Other measures included board closure, social distancing activities such as school, and working places closure and cancellation of mass gatherings. Measures were enforced with administrative fines.

Singapore adopted multipronged containment measures to contain the COVID-19 epidemic. Along with the border controls, and community education and precautions, the country implemented aggressive interventions to contain local transmission of the infection. These measures included surveillance among different population groups, patient isolation, and quarantine, active monitoring of contacts. The small number of cases allowed to undertake individualized efforts. Enhanced surveillance activities lead to rapid identification and isolation of cases and quarantine of close contacts that were effective in suppressing the expansion of the epidemic (Ng et al., 2020).

Table 1 below presents a set of measures deployed by South Korea, Hong Kong and Singapore in response to the COVID-19 epidemic. The summary of the measures is presented below, and more details are given in Annex 2.

Table 1 Interventions by countries

Intervention	**Country** / **Short description**	**South Korea**	**Hong Kong**	**Singapore**
Emergency response mechanisms	Country level coordination	+	+	+
	Declaring state of emergency	+	+	-
Risk communication & public engagement	Effective communication	+	+	+
Case finding, contact tracing and management	Active case finding, contact tracing & monitoring,	+	+	+
	Mobile apps to track interaction	+	-	-
	Quarantine and isolation	+	+	+
	Travel restrictions	+	+	+
Surveillance	Surveillance systems	+	+	+
	Intensive testing	+	+	+
	Mass testing including drive-through testing stations	+	-	-

Intervention	Country / Short description	South Korea	Hong Kong	Singapore
Social distancing	School closure	+	+	-
	Working places closure	+	+	-
	Stopping mass gathering >250	+	+	+
Case Management	Ready hospitals for surge, triage procedures	+	+	+
Infection prevention & control (IPC)	Staff training in IPC and clinical management	+	+	+
The readiness of health care systems	Preparedness for the epidemic due to previous experience	+	+	+

Quick actions

→ Singapore, Hong Kong, and South Korea were well prepared for the Covid-19 epidemic due to previous experience with the SARS outbreak in 2003. The governments of all four countries **acted proactively and quickly shifted to enhanced preparedness stage**. Whole **national responses were well-coordinated and managed across the governmental structures, public, and private organizations and communities**.

→ Right after the announcement of an unknown virus in Wuhan (China), the countries activated preparedness plans and quickly deployed mitigation interventions.

Rigorous detection, strict quarantine, and isolation

→ Hong Kong and Singapore had all proactively implemented **travel restrictions** on passengers coming from the China mainland, contravening the WHO insistence that travels bans were not necessary (Barron, 2020).

→ Singapore was the first country that **suspended flights** from Wuhan. Returnees were placed under 14-day compulsory leave. Every possible contact of confirmed cases was identified through rigorous investigation (using police forces), and close contacts were put under **mandatory quarantine**. **Mass fever screening** was instituted at entry points to offices, schools, hotels, community centers, and places of worship. (Barron, 2020; Niehus, Salazar, Taylor, & Lipsitch, 2020; Wong, Leo, & Tan, 2020) Violation of the quarantine rules is subject to fines up to 7,300 USD.

→ Hong Kong quickly set up systems to identify every case in the territory. Self-quarantine for 14 days was used for those who have been in China in the preceding 14 days. The diagnostic tests were developed and rapidly deployed to every major hospital in the city. Holiday camps and newly constructed public-housing units that were still vacant were rapidly repurposed into quarantine facilities. Since mid-March, Hong Kong uses **electronic wristbands to enforce quarantine measures**. (Cheng et al., 2020, (Cowling & Lim, 2020), Beaubien, 2020, (Saiidi, 2020).

→ South Korea used **novel methods for contact tracing,** including medical facilities records checking, a phone-based global positioning system (GPS), card transaction records, and closed-circuit television. Contact investigations provided accurate information on the location, and time of exposure, and details of the situation, thus reducing omissions in a

patient's route due to recall or confirmation bias. In light of the recent epidemic situation, South Korea has restricted the screening process for travelers from the US by introducing testing for all travelers and putting negatives in self-quarantine for 14 days. (COVID-19 National Emergency Response Center Epidemiology & Case Management Team KCDC, 2020; Parodi et al., n.d.)

→ All four countries initiated **enhanced laboratory surveillance** to widen the detection of cases. In Hong Kong, surveillance initially included pneumonia cases without a microbiological diagnosis, which was expanded to all inpatients with pneumonia and a purposively sampled proportion of outpatients and emergency attendees. In total, about 1500 individuals were tested per day (Legido-Quigley et al., 2020).

→ From the third day after China announced a novel virus, Singapore's Ministry of Health alerted all physicians to identify any patient with pneumonia and a recent travel history to Wuhan. Pneumonia in hospital and primary care, severely ill patients in hospital intensive care units and deaths with possible infectious cause, and influenza-like illness (ILI) in sentinel primary care clinics were traced. Doctors were also allowed to test patients whom they viewed with suspicion for clinical or epidemiological reasons.

→ South Korea experienced a large outbreak of COVID-19 stemming from church services in one of the cities that lead to 55% of confirmed cases in the country. This and some other clusters were driving force of the epidemic. In response, the government initiated **active contact tracing** that enabled the **identification and early isolation of infectious individuals**. Other **creative testing measures included 50 drive-through (testing of individuals in their vehicles)** testing stations across the country, where it takes only 10 minutes to go through the whole procedure. Test results are available within hours. The country has the capacity to process up to 15,000 diagnostic tests a day with the active participation of private laboratories that accounted for 90% of lab capacity in the country. In total, about 200,000 tests were done that resulted in the third-largest number of confirmed infections after China and Italy (Bicker, 2020; Kuhn, 2020; Park & Power, 2020).

Social distancing and public health measures

→ Singapore has not implemented school closures, or other major social distancing measures, as there is no evidence of widespread community transmission. (Lee, Chiew, & Khong, 2020) Only large gatherings were closed.

→ South Korea has adopted a gentler policy of voluntary containment and keeping citizens updated on its efforts in near real-time. (Strother, 2020) Thermal imaging cameras were placed in the entrances to major buildings, bottles of hand sanitizers have been placed in lifts. People dressed in costumes at subway entrances reminding people to wash their hands.

→ Hong Kong has also deployed very extensive measures to encourage social distancing. Many civil servants were asked to work from home for the following month. Most large-scale events have been canceled or postponed. All kindergartens and schools were closed starting from January 27 until late April (20 April, 2020).

Effective communication

→ All four countries put efforts to deliver timely, transparent, and accurate information on a daily basis. Daily updates, press-conferences were done form the Ministries of Health,

experts, other sector representatives. Communication activities were centrally managed and coordinated.

→ As traditional communication strategies were not sufficient, the countries used various means of communication (social media, print media, posters, and videos in public places) to keep the population informed and advise about prevention strategies. Announcements included messages on regular handwashing, when, where, and how to use masks, the danger of saving masks to prevent them from becoming unavailable to frontline health workers.

→ South Korea used the alert system to inform the public on COVID-19 cases in certain areas. The messages identify where the patient had been prior to detection and at what time; they urge anyone who might have crossed paths with the individual to get tested immediately.

→ In Singapore, the announcement of upgrading the alert level in the country resulted in panic among the population, which was effectively managed by the Prime Minister's personal engagement. (Wong et al., 2020; Lee, Chiew, & Khong, 2020).

Economic response

→ In Singapore, the government offers self-employed people $100 Singapore dollars (USD 73) per day, or to the employers if the patient is salaried, while employers are prohibited from detracting quarantine days from staffers' annual leave. South Korea leader pledged $25 billion to deal with the crisis in the country.

Health System preparedness

Health Workers safety

- Infection control measures
    - Restricting health care workers from working if they have any upper respiratory tract symptoms, even in the absence of fever (Klompas, 2020).
    - Regular open staff forums along with face-to-face education sessions to provide "right-on-time" infection control updates and address staff concerns
    - Use of PPE among HCWs in performing aerosol-generating procedures (AGPs) even though for caring patients without clinical features and epidemiological exposure risk in the general wards. Performance of AGPs such as endotracheal intubation, open suctioning, and use of high flow oxygen had been shown to be associated with the risk factors for nosocomial transmission of SARS-CoV among HCWs (60% of transmission)
    - Regular hand hygiene compliance assessments in the hospitals
    - Provision of the surgical mask to all HCWs, patients, and visitors in clinical areas
    - Keeping 1-meter spacing between patients.
- Protection of first line HCW
- Special safety considerations for ICU staff involved in airway management
    - Use of infection isolation rooms

- If infection isolation rooms are not available to avoid non-invasive ventilation and high-flow-ventilation, this has **implications on the number of ventilators needed** and should be considered during ventilators projections.

Triage

- China example (see Picture 1 for management plan):
  - Free online clinic working around the clock to facilitate the patient triage. Through free online consultation, the hospital preliminarily judged the treatment urgency, recommended non-emergency patients to delay hospital appointments, or visit other non-anti-epidemic hospitals, **provided low-suspected patients treatment instruction when self-isolating at home, invited high-suspected patients to the designate hospital.** The online clinic effectively alleviated the hospital workload and facilitated the early detection of potential cases. (China)
  - The assigned personnel at the emergency department (ED) conducted pre-examination and triage to divide visits into low-suspected, high-suspected, and other patients, and required different patients to follow the specified routines to enter ED and separate the intra-ED space into high-risk and low-risk regions. For suspected cases, the hospital assigned an independent Fever Clinic Room, Fever Observation Room, and CT Examination Room. Cases confirmed through qRT-PCR and/or CT were transferred to Quarantine Ward while excluded patients went to other departments or back home. The ED region separation triage system reduced the cross-infection by restricting the activity ranges of both patients and ED personnel.
  - ED requirements had the highest priority. The hospital established a capable command system, implemented effective coordination mechanisms, provided the ED with PPE and medical devices preferentially, equipped the triage and high-risk-region personnel with standardized personal protection, withdrew or postponed non-urgent appointments and operations, and dispatched aid personnel from other departments to ED. These measures concentrated the limited supply through the hospital on the staff who mostly needed protection.
- Other examples
  - Hotline working 24 hours for advising patients on disease management, **identifying high-risk patients, and referring them to designated facilities.** (South Korea)
  - **Positive asymptomatic or mild cases placed in self-quarantine and monitored remotely through a smartphone app or checked regularly in telephone calls**. (South Korea)
  - **Treating patients with mild symptoms in residential centers or at home until a hospital bed becomes available**. When a bed is available, an ambulance picks the person up and takes the patient to a hospital with air-sealed isolation rooms. (South Korea)
  - 1) Screening all visitors for any respiratory symptoms that may be related to a virus, including fever, myalgias, pharyngitis, rhinorrhea, and cough, and excluding them from visiting until they are better; 2) **restricting health care workers from working if they have any upper respiratory tract symptoms, even in the absence of fever;** and 3) **screening all patients,** in those with positive screening results regardless of illness severity, using precautions (single rooms, contact precautions, droplet

precautions, and eye protection) and for patients with respiratory syndromes for the duration of their symptoms regardless of viral test results. (Klompas, 2020)

Economic challenges

There is an economic burden associated with suppression of the epidemic. China and South Korea experience shows that suppression is possible in the short term, whether it will be possible in the long run time will show (Ferguson et al., 2020, Scott, 2020).

Discussion

COVID-19 epidemic requires a combination of measures. Based on the China epidemic experience, WHO identified measures that are proven to interrupt or minimize COVID-19 transmission. The measure includes proactive surveillance to immediately detect cases, very rapid diagnosis and immediate case isolation, rigorous tracking, and quarantine of close contacts, and an exceptionally high degree of population understanding and acceptance of these measures (WHO, 2020e). These recommendations were published end of February 2020. However, the countries of our interest adopted these measures with some variations from the early stages of the epidemic.

Education and active communication with the public through risk communication and community engagement is one of the critical actions to be implemented at all stages of the epidemic ((WHO, 2020b). Authorities in all four countries have strong centrally managed coordination activities, and they capitalize on reliable and transparent information, use technologies, and various means of communication. These efforts helped to reduce misinformation and minimize the impact of fake news and created trust in the population (Barron, 2020).

Effectiveness of sole interventions might not be effective in combating the epidemic, e.g., Hellewell at al found that contact tracing and isolation might not contain outbreaks of COVID-19 unless very high levels of contact tracing are achieved (more than 70% of contacts traced), however, if adequate these interventions could contribute to reducing the overall size of an outbreak or bringing it under control (Hellewell et al., 2020), The other author similarly indicates that contacts tracing could be successful strategy in the early stages of the outbreak (Anderson et al., 2020). Analysis of four major clusters of the South Korean epidemic indicates that early social distancing measures were effective in containing the epidemic (Shim et al., 2020).

Social distancing as a key measure to stop the epidemic spread was put into practice quickly in Singapore, Hong Kong and South Korea with some variations. The WHO identifies social distancing as a key prevention and control measure, although admitting that further research is needed to measure its effect (WHO, 2020e). The studies based on the China epidemic indicate that social distancing measures reduce transmission in the early stage of the epidemic by 60%. (Anderson et al., 2020). A recent study by (Zhang et al., 2020) showed that daily contacts were reduced 7-9 fold during the COVID-19 social distancing in Wuhan and Shanghai, with most interactions restricted to the household. The research showed that social distancing alone was sufficient to control COVID-19 in these two cities; however, for other contexts, local specifics and age-mixing patterns should be considered (Zhang et al., 2020). The literature suggests that there are very large uncertainties around the effectiveness of social distancing policy in specific contexts, how long it will succeed, and the extent to which the population spontaneously changes behavior (Ferguson et al., 2020). Moreover, the economic costs of these policies will be profound, as shown by China and South Korea experience (Ferguson et al., 2020; Scott, 2020).

COVID-19 has a high rate of asymptomatic infection, and there is a chance that almost every second infected individual crosses the border undetected, therefore screening at the border has low sensitivity in detecting the infection (Quilty, Clifford, Cmmid nCoV Working Group, Flasche, & Eggo, 2020;). All four countries applied entry screening (with testing in some countries), which was followed by 14-day isolation or self-quarantine of travelers from China. Recently South Korea restricted the screening process for travelers from the US by introducing testing and putting negatives in self-quarantine for 14 days. To ensure high compliance to the isolation and self-quarantine rules, various

enforcement and technological solutions were used by the countries, such as electronic wristbands (Hong Kong), fines in Singapore and South Korea, monetary support in Singapore.

The WHO recommends immediate expansion of surveillance to detect transmission chains, by testing all patients with atypical pneumonia, conduct screening in some patients with upper respiratory illnesses and/or recent COVID-19 exposure, and adding testing for the COVID-19 virus to existing surveillance systems. (WHO, 2020e) All four countries initiated enhanced laboratory surveillance to widen the detection of cases. Singapore had the highest surveillance capacity among all other countries that contributed to suppressing the epidemic (Ng et al., 2020). It was estimated that if the countries globally had similar detection capacities, the global number of imported cases detected would be 2.8 times higher than the observed current number (Ng et al., 2020).

The need of COVID-19 rapid diagnostics for research and surveillance is recognized by the WHO (WHO, 2020e). By its latest 22 March interim guidance document on laboratory testing, the WHO identifies molecular (RT-PCR) testing as the current recommended method for the identification of infectious cases, serological assays are important for surveillance and research but are not recommended by the WHO for clinical diagnosis, as well as rapid tests for antigen detection. More evidence on test performance and operational utility are needed prior to the tests that are recommended for practice (WHO, 2020d). The literature indicates that South Korea and China have been using self-produced rapid (RT-PCR) diagnostic kits widely for their screening purposes (Chadwick, n.d.; Kwon, Ko, Shin, Sung, & Kim, 2020).

Hospital preparedness and activation of contingency plans is an absolute priority for the countries (ECDC, 2020b) WHO Critical Preparedness and Response actions call for activation of surge plans for health facilities (WHO, 2020b). Analysis of health system capacity and projections is critical to effectively respond to the needs of the patients. Evidence from Italy indicates that the health system appeared under significant pressure, and urgent actions were requested from the government to surge capacity (Remuzzi & Remuzzi, 2020). Despite the fact that Hong Kong and Singapore were well prepared after the SARS epidemic in 2003, both countries faced limited intensive-care unit bed capacity (Legido-Quigley et al., 2020). In South Korea, due to the overburden of hospital beds, severe cases were deprived of intensive care that prompted to relevant changes in the hospitalization strategy (Bicker, 2020). The recommendations from the China epidemic include the designation of treatment facilities for mild and for severe cases with intensive care capabilities (ECDC, 2020b). Patient triage principles prior to and after hospital admission are intended to minimize patient overload to the facility and avoid nosocomial transmission. (Cao et al., 2020).

Guidance for clinical care is available from the WHO (WHO, 2020a), CDC (CDC, 2020;) As evidence in COVID-19 clinical management is constantly accumulating, follow-up of the latest developments in therapeutic options is needed.

Experience from China and Italy showed that a significant proportion of cases (about 60%) in the early stage of the epidemic were among health care workers. Therefore Infection Prevention and Control activities are of critical importance. (ECDC, 2020b). Guidance documents on Infection Prevention and control are available from the WHO (WHO, 2020e), ECDC (ECDC, 2020b), and CDC (CDC, 2020). Training on standard Infection Prevention and Control precautions is required for all staff at primary and hospital levels (ECDC, 2020b). China's experience indicates that surveillance among health workers identified factors early in the outbreak that placed HCW at a higher risk of infection (WHO, 2020e). The countries provided enhanced infection control measures. Regular staff forums and face-to-face meetings were held on the correct use of Personal Protective Equipment. As a result, e.g., no nosocomial transmission of the virus was detected in Hong Kong (Wong et al., 2020)

(Cheng et al., 2020). The countries documented their infection prevention and control practices which are of critical importance for other countries' policies to take into consideration.

Finally, national/local health authorities should ensure the continuity of essential health services to the population through adoption of business continuity plans with relevant adjustments (ECDC, 2020b).

The countries' economies are expected to be hit by the epidemic (Ayittey, Ayittey, Chiwero, Kamasah, & Dzuvor, 2020). The epidemic containment measures are resource consuming, and low and middle-income countries will be especially vulnerable (Kates, Moss, & Oum, 2020). Therefore, during the prioritization of the response measures, countries should focus on high-risk groups, healthcare systems, and healthcare workers to ensure rapid detection and diagnosis of cases and protect healthcare staff, patients, and other contacts from exposure (ECDC, 2020b).

The country-level effectiveness of the interventions could be measured by the reduction of the reproduction number (R_0). However, it gives insights on the effectiveness of the combination of measures and not on a single intervention. All four countries aimed to suppress the epidemic. The aim of the suppression is to reduce the R_0 below 1.0 (For COVID-19 R_0 is 2.5 in China settings (ECDC, 2020b)). In Spain, Italy, Iran R_0 is >6.0. All countries achieved a reduction of the $R_{0.\,H}$owever, only South Korea, with the largest disease burden, managed to suppress the R_0 below 1.0 after 40 days from the epidemic started. Other countries' reproduction number value is between 1.0-2.5 (Abbott et al., 2020).

Aggressive and comprehensive responses to the COVID-19 epidemic in South Korea, where the epidemic was suppressed after the initial rise in Singapore and Hong Kong, which keep the case numbers low, is a valuable experience for other countries to consider in their anti-epidemic actions.

Annexes

Annex 1. Methodology

What is a Rapid Response Product

A Rapid Response product responds to requests from policymakers and stakeholders by summarizing the research evidence drawn from reviews and from primary research studies and provides them access to optimally packaged, relevant, and best available research evidence.

The preparation of this rapid response involved the following steps:

1. Formulating a clear review question on a high priority topic requested by policymakers and stakeholders;

2. Establishing what is to be done, and in what timeline;

3. Identifying, selecting and synthesizing the relevant research evidence about the question;

4. Drafting the Rapid Response in such a way that the research evidence is presented concisely and in accessible language;

5. Submitting the Rapid Response for Peer/Merit Reviews;

6. Finalizing the Rapid Response based on the input of the peer/merit reviewers; and

7. Final submission, validation, and dissemination of the Rapid Response

Evidence search and studies selection

The country selection was based on the following criteria: Closeness to China and thus being especially vulnerable to the spread of infection, greater reduction in transmission shown by the ability to contain the spread after 100th case, longer and flattering epidemic curve.

A search was performed using PubMed and Google. Key terms used for the search were COVID-19 AND country. The search was conducted on the 16th of March. PubMed search yielded 37 studies and other resources for all four countries. The titles of these resources were scanned, and relevant abstracts were retrieved (13). In Google search titles of the first 30 hints for each country were scanned, and 25 papers, web resources, newspapers, blogs, stories, reports, and guidelines from the Ministry of Health web page were retrieved.

For data abstraction, we used a framework based on the WHO critical preparedness, readiness, and response actions for COVID-19 (WHO, 2020b).

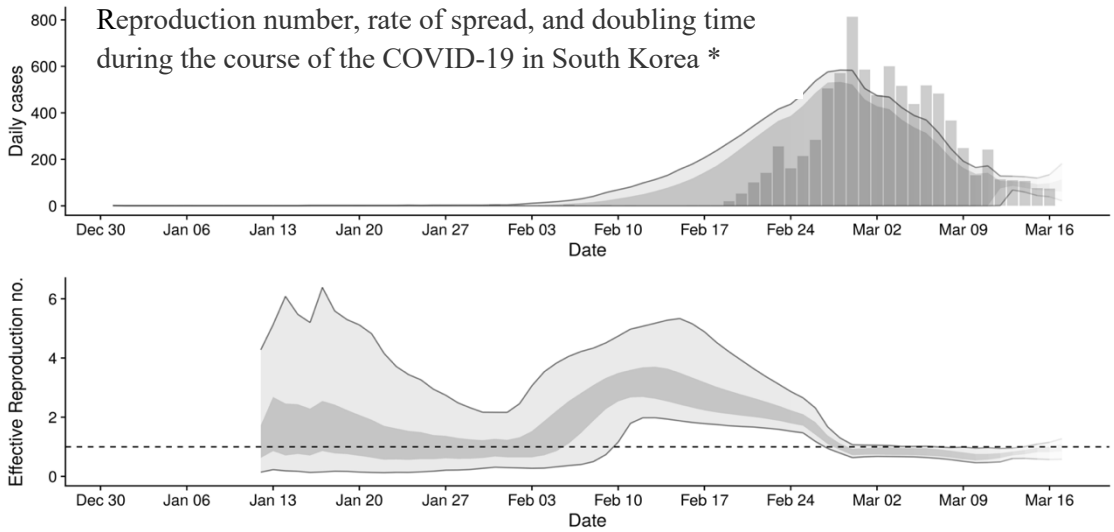
During the preparation of the rapid response product, CIF researchers participated in the coordination meetings at the Ministry of Internally Displaced Population from Occupied Territories, Health, Labour and Social Affairs, and at the Government of Georgia. The meetings helped to get more understanding of the country's readiness and policymakers' priorities and identify other urgent needs. One of the top priorities for the government is the health system’s preparedness. With the aim to partly respond to the needs, we expanded our search on the health system’s preparedness (surge plans, triage, hospital management, and infection control strategies) to other countries' experiences. The meetings also shaped the presentation of the recommendations in this rapid response products. As there was no assessment of the country readiness available for us, we tried to construct our recommendations to fit the country context and avoid general statements. The majority of the recommendations are stemming from the literature, however, few are based on discussions during the coordination meetings which are supported with the evidence whenever possible.

Annex 2 Country examples

South Korea experience

Short overview: East Asian nation on the southern half of the Korean Peninsula with 51.47 mln population.

The first case of COVID-19 diagnosed on January 20. After that, suddenly, South Korea's coronavirus cases multiplied 180-fold in two weeks. At its peak, medical experts were diagnosing more than 900 new cases a day, making South Korea the second-largest outbreak in the world. Although soon after South Korea managed to slow down the epidemic.



** A. Cases by date of report (bars) and estimated cases by date of onset. B. Time-varying estimate of the effective reproduction number. Light grey ribbon = 95% CI. Dark grey ribbon =IQR. Based on data from the 2020-03-17. Confidence in the estimated values is indicated by shading with reduced shading corresponding to reduced confidence*

Source:(Abbott et al., 2020)

Measures	Note	Description
Emergency response mechanisms	Includes country-level coordination	The country has entered a war against infectious disease. The leader has ordered all state agencies to operate around the clock and pledged $25 billion to deal with the crisis (Strother, 2020).
Risk communication and public engagement		In stark contrast to China's hard-handed tactics, such as locking down entire cities and tightly controlling the dissemination of information about the disease, Korea has adopted a gentler policy of voluntary containment and keeping citizens updated on its efforts in near-real-time (Strother, 2020). Communication campaign included: • **Official emergency alert**s on citizen's cellphone every time a new coronavirus case are reported in a certain area. The **messages** identify where the patient had been before detection and at what time; they urge anyone who might have crossed paths with the individual to get tested immediately.

Measures	Note	Description
		• The KCDC has opened a coronavirus hotline, holds **daily televised press conferences,** and offers personal hygiene advice that plays on a loop on many buses and in subway stations in Seoul. The announcement says: "When taking public transportation, please wear a mask; please make it a habit of washing your hands frequently when you cough, please block your mouth and nose."
Case finding, contact tracing and management	Active case finding, contact tracing, and monitoring, quarantine of contact and isolation	• The epicenter of the South Korean COVID-19 outbreak has been identified in Daegu, a city of 2.5 million people, approximately 150 miles South East of Seoul. The rapid spread of COVID-19 in South Korea has been attributed to one case linked to a superspreading event that has led to more than 3,900 secondary cases stemming from church services in the city of Daegu (55% of confirmed cases are linked to this cluster of infections). Three other clusters have been reported, including one set in Chundo Daenam hospital in Chungdo-gun (118 cases), one set in the gym in Cheonan, (92 cases), and one Pilgrimage to Israel cluster (49 cases). These few clusters have become the major driving force of the infection (Shim et al., 2020) • According to enhanced the 2019-nCoV quarantine guideline in the Republic of Korea, those who have 'routine contacts' with confirmed cases regardless of the times requires a mandatory period of 14 days of self-quarantine (KCDC, 2020) o Local government officials are in charge of managing the people who are self-quarantine as 1:1 system. The central government will provide the proper information of contacts into local government so that they can take proactive action and cooperation. o In light of the recent surge in COVID-19 cases in the United States and the rise in the number of imported cases from the US, starting from 27 March, a stronger screening process will be applied for inbound travelers from the United States. All symptomatic persons entering from the US, regardless of nationality, will be required to wait for testing in a facility within the airport. Persons who test positive will be transferred to a hospital or "Life Treatment Center." Persons who test negative will enter self-quarantine at home for 14 days. (Press release update on the quarantine guideline as of March 25) • South Korea uses **novel methods for contact tracing** to overcome recall and confirmation biases that can occur while determining the location of the contact that is **checking medical facilities records, a phone-based global positioning system (GPS), card transaction records, and closed-circuit television (CCTV)**. Government authorities can then make some of this public, so anyone who may have been exposed can get themselves - or their friends and family members – tested (COVID-19 National Emergency Response Center Epidemiology & Case Management Team KCDC, 2020; Parodi et al., n.d.) 1. **History of using medical facilities and visiting pharmacies -** History of using medical facilities and visiting pharmacies were used to estimate the window of time of infection, through an accurate evaluation of the clinical

Measures	Note	Description
		symptoms of the infectious disease, and initial onset of the symptoms. If a medical facility was included in the patient's route, quarantine of the medical facility was conducted. **2. GPS –** In addition to the interviews, identification of the routes that the patient could not remember was also possible. GPS uses cellular phone networks; therefore, there are limitations in identifying the exact locations of a patient's route. 3. **Credit card transaction log -** Credit card transaction logs were used to assess the consistency in the route of the patient identified through the interview, and the scope of contacts was determined by specifying the locations visited. 4. **CCTV -** By checking the video footage of the location of a patient's path, CCTV provided help to identify the details of each situation. For example, CCTV was used to evaluate the level of exposure risk by determining whether the patient wore masks or had respiratory symptoms such as a cough. • In South Korea, authorities have a different response to a similar-sized outbreak. They are testing hundreds of thousands of people for infections, and **tracking potential carriers like detectives, using the cell phone and satellite technology** (Parodi et al., n.d.)
Surveillance	Surveillance using existing resp disease surveillance systems and hosp. based surveillance	• South Korea applied **mass testing free of charge for its population** through improved public communications and the use of technology (Kuhn, 2020; Parodi et al., n.d.; Thompson, 2020). • Creative measures, including about **50 drive-through testing stations across the country**, where it takes only 10 minutes to go through the whole procedure, are adopted for the surveillance. Test results are available within hours. 1. The test center consists of four trailerlike offices with white canopies in front. Doctors in full protective suits and goggles take the driver's temperature with an infrared thermometer and hand out a questionnaire to fill out. If you're running a fever and, in the doctor's opinion, maybe at risk based on where you've been or whom you've contacted, you're eligible for a test. **Only the driver is tested — passengers are not.** 2. **Drivers advised to hit the recirculation button** so that if they are sick, they can keep their pathogens to themselves, in their car, and avoid infecting the medical personnel doing the testing. • This testing capability has enabled the country to identify patients early and minimize the harmful effects, health experts say. But this also led to South Korea has the second largest number of confirmed infections in the world after China, although this was superseded by Italy this week. • **It's much better to test and then quarantine a specific person** than to do a citywide or provincewide lockdown, which in certain ways prevents the virus from leaving the province but actually doesn't make the province any less likely to have high infection rates. Although, it requires **years of investment in complex health care infrastructure, including lab hardware and technicians to analyze samples, logistics for moving goods, and**

Measures	Note	Description
		providing services and information technology to keep supplies and data moving. Any bottleneck or shortage of these elements can cost time and lead to more infections and deaths (Kuhn, 2020). • The problem is that "in South Korea, private institutions account for 90% of the medical system, and 90% of our testing capacity," especially laboratories to analyze samples. "So, we needed the support of the private sector." Now, **public and private sectors cooperate more efficiently**, having come together in voluntary collaboration. And the KCDC reorganized to respond more effectively to epidemics, including a branch specifically in charge of testing and diagnosing infectious diseases (Kuhn, 2020). o In the battle to contain the contagion, these labs have become the front line. South Korea has created a network of 96 public and private laboratories to test for coronavirus (Bicker, 2020)
Public health measures	Hand hygiene, resp etiquettes, social distancing	• Although China introduced strict social distancing and extensive monitoring of citizens, South Korea applied a gentle distancing policy. Without harming the principle of a transparent and open society, a **response system that blends voluntary public participation** with creative applications of advanced technology was introduced (Park & Power, 2020) • Dealing with the threat of coronavirus is the new norma (Bicker, 2020)l: o Most people wear masks (if they can get hold of one). o There are thermal imaging cameras in the entrances to major buildings. o Bottles of hand sanitizers have been placed in lifts. There are even people dressed in costumes at subway entrances reminding you to wash your hands. • Although some experts emphasize that South Korea's response is not perfect, South Korea does not have enough protective masks - it has started rationing them - and it is trying to hire more trained staff to process tests and map cases. **When testing in a country is limited, he said, the authorities have to take bolder actions to limit movement of people**. (Parodi et al., n.d.)
Case Management	Treatment Ready hospitals for surge, triage procedures	• In addition to helping work out who to test, South Korea's data-driven system helps hospitals manage their pipeline of cases. People found positive are placed in self-quarantine and monitored remotely through a smartphone app, or checked regularly in telephone calls until a hospital bed becomes available. When **a bed is available, an ambulance picks the person up and takes the patient to a hospital with air-sealed isolation room**s. All of this, including hospitalization, is free of charge. (Parodi et al., n.d.) • Although there have been **missteps** too (Bicker, 2020):

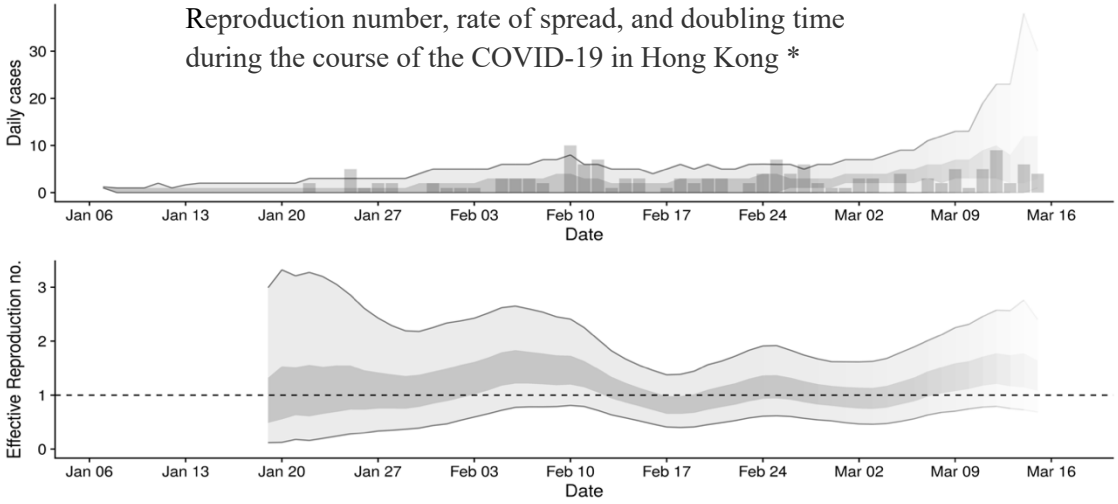
Measures	Note	Description
		○ At least two patients died waiting for a hospital bed in Daegu, the worst affected city. The initial reaction was to quarantine everyone infected with the virus in a hospital bed, but now the doctors have learned to treat those with mild symptoms in residential centers and leave the clinical beds for those needing critical care. ○ "We can't quarantine and treat all patients. Those who have mild symptoms should stay home and get treated." ○ "We should change our end goal strategy to lower death rates. So, other countries like Italy, that see huge numbers in patients should also change their strategies as well."
Other note	Lab testing	• A **novel protocol was developed to be used as a primary screening platform for asymptomatic people to be tested for a real negative using** a real-time reverse-transcription PCR (rtPCR)-based assay composed of easy specimen self-collection from a subject via pharyngeal swab, Trizolbased RNA purification, and SYBR Green-based rtPCR**.** This protocol shows an accuracy and sensitivity limit of 1-10 virus particles as we tested with a known lentivirus. **The cost for each sample is estimated to be less than 15 US dollars. The overall time it takes for an entire protocol is estimated to be less than 4 hours.** We propose a cost-effective, quick-and-easy method for early detection of SARS-CoV-2 at any conventional Biosafety Level II laboratories that are equipped with an rtPCR machine (Won et al., 2020). • However, **the results should not be considered as a clinical diagnosis, which requires medical expertise and staff for proper diagnosis.** Those who already show obvious symptoms of COVID-19 should not rely on our detection protocol but resort to certified hospitals and health agencies. Our protocol should be useful when the purpose of the testing is to identify the negative people, who need to work, study, and sport normally (Won et al., 2020)
	Lessons learned from previous outbreaks	• South Korea learned the risk of new infection and its ramifications from the experience of the Middle East Respiratory Syndrome (Mers) back in 2015. To learn from the past and prepare systems in advance. that might be the true power to overcome this new kind of disaster (Bicker, 2020)

Hong Kong experience

Short overview: Sharing a border with China, Hong Kong has a population of 7.3 mln.

The first case diagnosed on January 23. As of March 27, 2020, Hong Kong had 518 confirmed cases, including four deaths.

Reproduction number, rate of spread, and doubling time during the course of the COVID-19 in Hong Kong *



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Source:(Abbott et al., 2020)

Measures	Note	Description
Emergency response mechanisms	Includes country-level coordination	Hong Kong began inter-ministerial coordination within the first week of the COVID-19 outbreak. Intragovernmental coordination was improved because health authorities drew on their experiences of severe acute respiratory syndrome during H5N1 avian influenza and H1N1 pandemic. State of emergency on 25th of January, 2020 in response to growing concern over the spread of a coronavirus (Legido-Quigley et al., 2020)
Risk communication and public engagement		• All direct costs for treating patients are borne by the governments. • The key measures include a bundle of early recognition, isolation, notification, and molecular diagnostic for all suspected cases (Barron, 2020) • The Chief Executive, Mrs. Carrie Lim has convened the Steering Committee cum Command Center to tackle the COVID-19 situation that resulted in a decision to implement disease prevention and control measures including the following: Travel restrictions between the Mainland and Hong Kong, urging people to stay home for 14 days who have come from highly affected areas, giving advises to those who need to go out to use surgical masks for 14 days, identifying centers for

Measures	Note	Description
		quarantine, conducting worldwide procurement of surgical masks and other materials in order to ensure adequate supplies for tackling the disease (HKSR, 2020)
Case finding, contact tracing and management	Active case finding, contact tracing, and monitoring, quarantine of contact and isolation	• Hong Kong along with Singapore had all proactively implemented travel restrictions on passengers coming from the mainland, contravening the World Health Organization's [WHO] insistence that travel bans were not necessary (Cowling & Lim, 2020) • Quickly set up systems to try to identify and treat every case in their territory (Beaubien, 2020). Self-quarantine for 14 days for those who have been in China in the preceding 14 days (Cowling & Lim, 2020) • Holiday camps and newly constructed public-housing units that were still vacant were rapidly repurposed into quarantine facilities (Cowling & Lim, 2020) • Hong Kong developed **diagnostic tests and rapidly deployed them to labs at every major hospital** in the city (Beaubien, 2020) • All suspected cases were isolated in an airborne infection isolation room (AIIR) for contact, droplet, and airborne precautions. Suspected cases were notified to the Centre for Health Protection, Department of Health, and Hospital Authority (Cheng et al., 2020) • Use electronic wristbands to enforce quarantines and reduce the spread of the new coronavirus. Putting all arriving passengers under a two-week quarantine and medical surveillance (Saiidi, 2020) • Hong Kong declared a state of emergency on 25th of January, 2020 in response to growing concern over the spread of a coronavirus, announcing it will close schools for three weeks and impose a limited transportation ban (Kim, 2020)
Surveillance	Surveillance using existing resp disease surveillance systems and hosp. based surveillance	• Initially, only pneumonia patients without a microbiological diagnosis were tested, later surveillance has been broadened to include all inpatients with pneumonia and a purposively sampled proportion of outpatients and emergency attendees totaling about 1500 per day (Legido-Quigley et al., 2020) • Progressively stepped up infection control measures by **widening the clinical and epidemiological criteria of surveillance for early recognition and isolation of index case according to the evolving of the epidemic** (Barron, 2020; Wang et al., 2020)
Public health measures	incl hand hygiene, resp etiquettes, social distancing	• **Social distancing** was put into practice quickly. Schools remain closed through Easter. Normally bustling shopping streets, residents voluntarily stay at home. Many businesses and have either shuttered or asked employees to work from home. Similarly, civil servants were asked to work from home for the following month. Movie theaters, churches, and basketball courts sit empty. Mass gatherings are canceled (Cao et al., 2020; Cowling & Lim, 2020)
Case Management	Treatment	• With total 40,000 hospital beds, some 1,000 are negative-pressure beds, allowing confirmed cases to be properly isolated (Cowling & Lim, 2020)

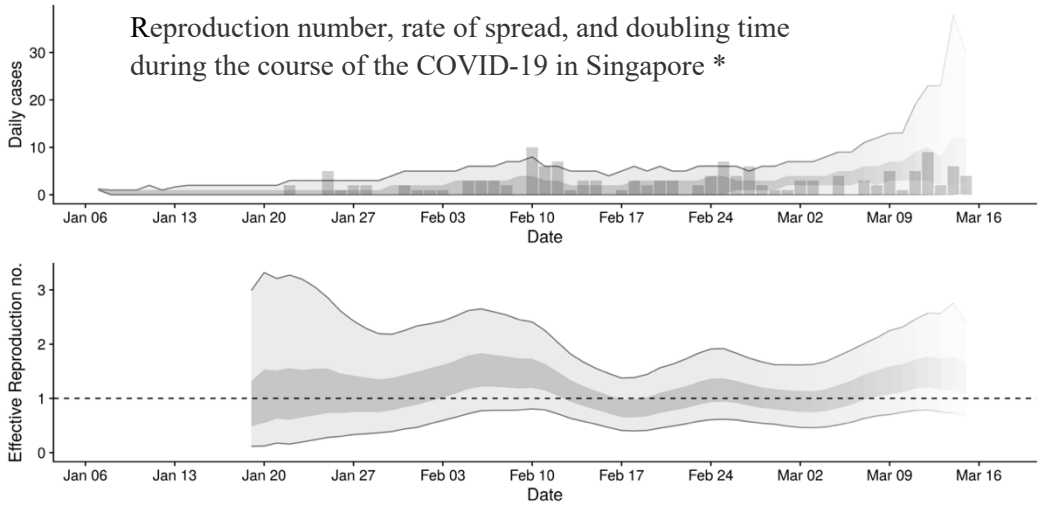
Measures	Note	Description
	Ready hospitals for surge, triage procedures	• Some practical suggestions for staff safety during emergency management of patients: All aerosol-generating procedures should be done in an airborne infection isolation room. Double-gloving might provide extra protection, Airway devices providing 6 L/min or more of oxygen are considered high- flow and is discourage use if an airborne infection isolation room is unavailable (Cheung, Ho, Cheng, Cham, & Lam, 2020) In Hong Kong, intensive-care bed capacity is limited, hospital supplies are running low but have not yet impacted clinical management (Legido-Quigley et al., 2020)
Infection prevention and control (IPC)	Staff training in IPC and clinical management	• With reference to experience in the outbreak of COVID19, almost 60% of nosocomial acquisition of a virus was HCWs. It is critically important to implement proactive infection control measures, which must be planning ahead (Cheng et al., 2020) • Enhanced infection control measures with a clear illustration of the choice of **personal protective equipment (PPE)** were enforced. Regular open staff forums were held along with face-to-face education sessions to provide "right-on-time" infection control updates and address staff concerns, if any. Practical training sessions of using PPE were performed by the hospital infection control team. Hand hygiene compliance assessments were conducted regularly in our hospitals (Cheng et al., 2020) • Infection control measures were enhanced by the implementation of the standard, contact, droplets, and airborne precautions for suspected or confirmed cases. PPE was used among HCWs in performing **aerosol-generating procedures (AGPs**) even though for caring patients without clinical features and epidemiological exposure risk in the general wards. Performance of AGPs such as endotracheal intubation, open suctioning, and use of high flow oxygen had been shown to be associated with the risk factors for nosocomial transmission of SARS-CoV among HCWs. • In addition, the provision of the surgical mask to all HCWs, patients, and visitors in clinical areas was implemented since day 5. Although wearing surgical masks alone was not clearly associated with the protection of a person from the acquisition of SARS-CoV, wearing a surgical mask by either HCWs or patients had shown to reduce the risk of nosocomial transmission of an influenza pandemic. Hand hygiene among HCWs and patients were promoted and enforced. With these measures, there was zero nosocomial transmission of the virus since the importation of the first confirmed case since day 22 in Hong Kong(Cheng et al., 2020) • Vigilance in hand hygiene practice, wearing of surgical mask in the hospital, and appropriate use of PPE inpatient care, especially performing AGPs are the key infection control measures to prevent nosocomial transmission of SARS-CoV-2 even before the availability of effective antiviral agents and vaccine (Cheng et al., 2020) • Patient cared in a ward with 1 meter spacing between patients (Cheng et al., 2020)
Other note	Lessons learned from previous outbreaks	• Despite mistrust of the government, which runs deep after nine months of often violent street demonstrations, faith in the public health system—one of the world's best—remains intact (Barron, 2020)
		• Hong Kong has been hailed for using those hard-won lessons to combat the new coronavirus—officially COVID-19 and a relative of SARS (Barron, 2020)

Singapore experience

Short overview: Singapore is an independent city-state 3400 km (2125 miles) from Wuhan, but as a major air hub had an average of 330 000 visitor arrivals from China each month in 2019. Of the five million people who left Hubei before Chinese New Year, over 10,000 flew to Singapore.

The first case diagnosed on January 23. As of Mar. 27, the city-state had 732 cases and two deaths.

Reproduction number, rate of spread, and doubling time during the course of the COVID-19 in Singapore *



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Source:(Abbott et al., 2020)

Measures	Note	Description
Emergency response mechanisms	Includes country-level coordination	• Singapore promptly shifted its public health response level to "enhanced preparedness" (Wong et al., 2020) • Ministerial press conferences. Whole-of-nation response measures both pre-planned and innovated, were put in place across government, public and private organizations, and communities and residences (Lewis & Yap, 2020) • Singapore and Hong Kong began inter-ministerial coordination within the first week of the COVID-19 outbreak. Intragovernmental coordination was improved because health authorities drew on their experiences of severe acute respiratory syndrome during, H5N1 avian influenza and H1N1 pandemic (Legido-Quigley et al., 2020)
Risk communication and public engagement		• Traditional communication channels are inadequate. Singapore has been utilizing print, broadcast, websites, and social messaging platforms such as WhatsApp, Twitter, Telegram, and Facebook on a daily basis since the first imported case was identified to keep the population informed and advised about what to do to reduce the risk of infection (Wong et al., 2020) • Public education includes messages on regular handwashing and seeking medical treatment early and staying at home when unwell. The use of masks was only encouraged for ill persons to prevent them from infecting others. The government distributed four masks to every household (Lee, Chiew, et al., 2020)

Measures	Note	Description
		• Daily updates from the Ministry of Health and advisories across all sectors. • Parallel messaging through non-tech platforms (e.g. cartoons, print-media, posters). • Rebuttal of fake news (Lewis & Yap, 2020). The ministry of health website along daily updates provides clarification on misinformation • Active engagement of many specific groups ranging from health care professionals to taxi drivers through conventional approaches as well as through social media and town hall meetings (Wong et al., 2020) • The prime minister's personal engagement with the public, his speech after the government announced its outbreak alert that resulted in panic was vital (Barron, 2020) • Assurance that all health care related to the disease would be free (Beaubien, 2020) • Live forum of experts that included an open discussion with questions from the public (Lee, Gan, Soon, & Jeyakumar, 2020)
Case finding, contact tracing and management	Active case finding, contact tracing, and monitoring, quarantine of contact and isolation	• Singapore, along with Hong Kong proactively implemented travel restrictions on passengers coming from the mainland, contravening the World Health Organization's [WHO] insistence that travel bans were not necessary (Barron, 2020) • On January 3, started temperature screening at its airport of all travelers arriving from Wuhan. • The range of public health measures that were instituted and rapidly escalated included aggressive contact tracing and quarantine of close contacts of confirmed cases (namely persons who had spent a prolonged period within 2 m of a confirmed case), travel advisories and then entry restrictions on people traveling from Hubei, and on January 31, entry restrictions on people who had traveled to China in the preceding 14 days. • Returners from China were placed under a 14-day compulsory leave of absence from work • All confirmed cases are isolated until two consecutive respiratory samples for RT-PCR become negative over 2 days. • Close contacts are identified, and those individuals without symptoms are quarantined for 14 days from last exposure (Wong et al., 2020) • Contact tracing of cases and their contacts, mobilizing not only the Ministry of Health staff but also members of the police and other partners (Lewis & Yap, 2020). Hunting down every possible contact of those infected. The process, which operates 24/7, starts with patient interviews and has also involved police, flight manifests and a locally developed a test for antibodies, which linger even after the infection clears (Barron, 2020) • Mass fever screening through thermal temperature scanners is widely instituted at the entry to public buildings, such as offices, hotels, community centers and places of worship (Lee, Chiew, et al., 2020) • Singapore detects almost three times more cases than the global average due to its strong disease surveillance and fastidious contact tracing (Niehus et al., 2020)

Measures	Note	Description
		• Anyone flouting the quarantine for the first time may be fined up to $10,000 (7.300 USD), jailed up to six months, or both. The penalty is higher for subsequent breaches.
Surveillance	Surveillance using existing resp disease surveillance systems and hosp. based surveillance	• On January 2, 2020 (on the third day after China informed the WHO of a novel virus) Singapore's Ministry of Health alerted all physicians to identify any patient with pneumonia and a recent travel history to Wuhan (Wong et al., 2020) • On January 2, 2020, days after the first report of the disease from China, the MoH developed a local case definition and advised all physicians to be vigilant for suspected COVID-19. The case definition was updated five times (Ng et al., 2020) • An enhanced surveillance system was set up to detect COVID-19 among all cases of pneumonia in hospital and primary care, severely-ill patients in hospital intensive care units and deaths with possible infectious cause, influenza-like illness (ILI) in sentinel primary care clinics. Finally, doctors were also allowed to test patients whom they viewed with suspicion for clinical or epidemiological reasons (Barron, 2020; Jombart et al., 2020; Lewis & Yap, 2020) • Physicians are mandated to report all suspected and confirmed COVID-19 patients through a centralized disease notification system (Ng et al., 2020) • After an initial increase in locally transmitted cases, the number of newly identified cases decreased after approximately one month, determined by symptom onset dates. This decrease is likely a result of the early implementation of surveillance and detection measures while the numbers of patients were still small, and individual-level containment was possible; a larger number of cases would have driven community transmission. Singapore had the highest surveillance capacity among all other countries. If other countries had similar detection capacities, the global number of imported cases detected would be 2.8 times higher than the observed current number (Ng et al., 2020)
Public health measures	incl hand hygiene, resp etiquettes, social distancing	• Daily messages to the public from a government WhatsApp group and constant messaging on handwashing and what to do if unwell. • Singapore has not implemented school closures or other major social distancing measures, as there is no evidence of widespread community transmission, and rates of COVID-19 infection among children remain low (Lee, Chiew, et al., 2020). Precautionary measures such as reducing mixing across classes or schools have been implemented to limit possible disease transmission (Ng et al., 2020) • All ticketed cultural, sports and entertainment events, with 250 participants or more, were cancelled. For all other mass gatherings including private functions and religious services, organisers were advised to put in place the following precautions: Reduce the scale of events to below 250 participants where possible; Reduce the crowding of participants and improve ventilation. Put in place temperature and health screening measures, as well as turn away persons who are

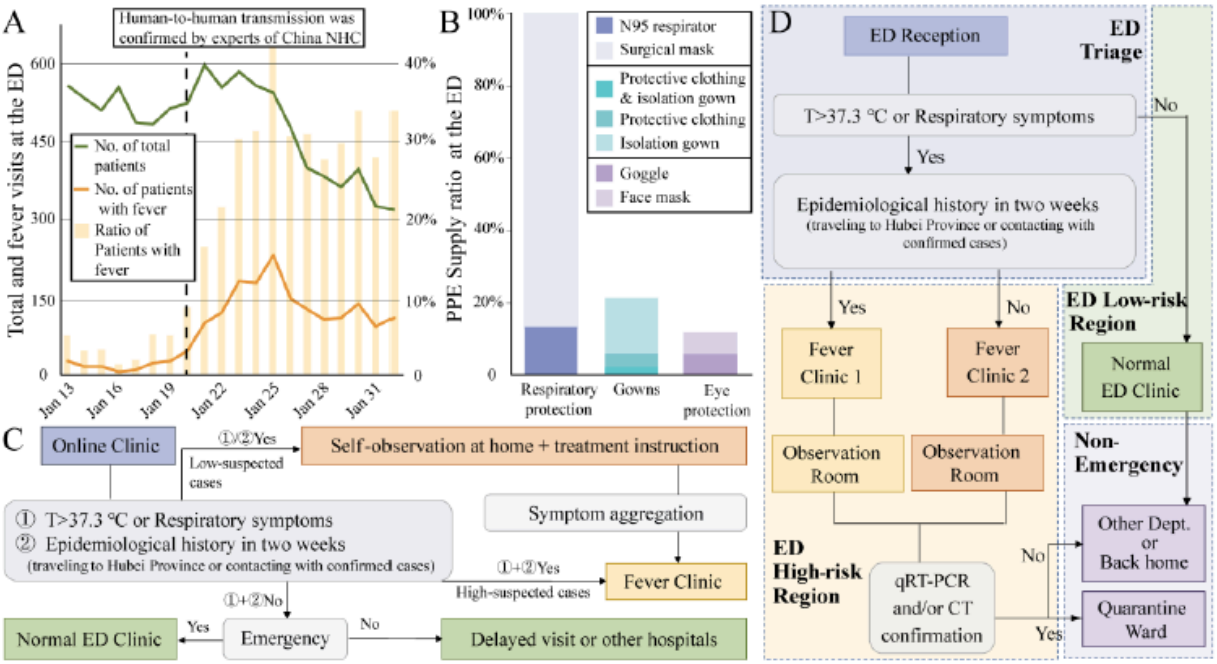
Measures	Note	Description
		unwell; and put in place measures to facilitate contact tracing if needed, such as obtaining contact details of participants (MoH Singapore, 2020)
Case Management	Treatment Ready hospitals for surge, triage procedures	• A network of more than 800 Public Health Preparedness Clinics (PHPCs) was activated to enhance the management of respiratory infections in the primary care setting, with subsidies extended to Singapore residents to incentivize them to seek care at these PHPCs. As early COVID-19 disease is mild and undifferentiated, medical practitioners were instructed to provide extended medical leave of up to five days for patients with respiratory symptoms. This allowed possible COVID-19 cases to self-isolate at home to reduce the number of undetected cases seeding community transmission. Those with persistent or worsening symptoms are advised to return to the same doctor for evaluation and referral for testing. **Movement of patients and doctors between healthcare institutions was also limited to prevent multiple institutions from being affected at the same time** (Lee, Chiew, et al., 2020) • Although published reports to date have identified preexisting chronic noncommunicable diseases as being a risk factor for clinical deterioration, the experience to date in Singapore is that patients without significant comorbid conditions can also develop severe illness (Wong et al., 2020) • Most of ICU beds were single rooms (infrastructure after 2003 SARS) • Infection control not only involved strict adherence to personal protective equipment for the individual but also involved **changes in group dynamics -** avoiding potential spread between teams (Liew et al., 2020) • Train non-ICU acute medical staff dealing with critically ill patients prior to ICU admission, especially for resuscitation (Liew et al., 2020) • ECMO use. Prepared cohort of all COVID-19 patients in the ICU and have a satellite team to help in management (Liew et al., 2020) • **Staff morale took an early hit due to multiple factors,** including increased workload due to implementation of strict infection control measures, **uncertainty over the effectiveness of personal protective equipment,** anxiety over the lethality of any infection, concern for the well-being of their family members (Liew et al., 2020) • **Intensive-care unit bed capacity is limited** (Legido-Quigley et al., 2020)
Societal response	Development of all-of-society & business continuity plans	• To make quarantine less onerous, the government offers self-employed people $100 Singapore dollars ($73) per day. The money goes to their employers if they are salaried while employers are prohibited from detracting quarantine days from staffers' annual leave. This allowance is not given to tourists.
Other note	Lessons learned from previous outbreaks	• Since its **experience with the SARS** outbreak in 2003, when 238 people were infected, including several health care professionals, and 33 patients died, Singapore has been systematically **strengthening its ability to manage another emerging infectious disease outbreak**. These include the construction of a new purpose-built National Centre for Infectious Diseases (a 330-bed purpose-built infectious diseases management facility) and National Public Health

Measures	Note	Description
		Laboratory; scaled up of testing capacity rapidly covering to all public hospitals in Singapore, that is able to handle 2,200 tests a day for a population of 5.7m; significant expansion in the number of negative-pressure isolation beds throughout the public hospital system; stockpiling of personal protective equipment (PPE) and masks; establishment of formal platforms for multi-Ministry and cross-agency coordination; development of a strong capability to perform contact tracing quickly and at scale; training of health professionals including in the correct use of PPE; and building more biosafety level 3 laboratories. In addition, as part of Singapore's major investments in biomedical science and clinical research and translation capabilities, a significant focus has been placed on building expertise in infectious diseases (Wong et al., 2020) • Singapore's response may not be directly translatable elsewhere. Since independence in 1965, it has been ruled by a single party that maintains tight control and is rarely subject to public criticism. Amid the coronavirus outbreak, quarantine and isolation protocols are strictly enforced (Barron, 2020) • However, **several challenges** lie ahead. Firstly, the longer the outbreak persists, the more chains of community transmission and missed cases are present, and the **more difficult it will be to link cases and contain the spread**. Contact tracing and quarantine are **resource-intensive activities and may not be sustainable in the long run**. Secondly, some individuals who continue to work or attend social functions while symptomatic are driving disease spread, leading to substantial community transmission. Thirdly, with global spread, the force of infection from imported cases will be substantial, leading to new waves of infection (Lee, Chiew, et al., 2020)

Annex 3 Solutions from the field

Triage Algorithm – example from China

Picture 1. West China Hospital Emergency Management Plan During the COVID-19 Epidemic with estimates of ED Workload, PPE shortage



Legend:

A. The daily number and ratio of fever visits at the ED from January 13 to February 1, 2020

B. The PPE supply ratio at the ED of West China Hospital on January 25.

C. The illustration of online clinic triage of West China Hospital.

D. The illustration of ED triage and region separation.

Critical care issues and solutions for Covid-19

(Liew et al., 2020)

Issues	Principles	Solutions
Infection control	1. Avoidance of cross-contamination among HCW 2. Education and re-education on personal protective equipment and use of powered air-purifying respirators 3. Provision for workflows to cater to special groups, such as pregnant women with acute respiratory illness who are in labor 4. Enhanced surveillance for infection in HCW 5. Strong emphasis on proper hand hygiene for all 6. Robust visitor screening and management	• A dedicated roster to segregate "clean" and isolation teams, and to provide for standby • Provision of clean scrubs for HCW to change into before duty; showering facilities at the end of shift • Education and re-education on personal protective equipment and use of powered air-purifying respirators, especially for isolation teams • Allow isolation teams to have a **2-week off-duty observation period ("wash-out" period), after every period of ward cover if manpower allows** • Mandatory reporting of twice-daily temperature monitoring by all HCW • Advance declaration of leave and overseas trips by HCW • Screening questions are regularly updated as case definitions evolve over time, especially for known clusters of infection in the community • Provision of thermal scanners at the doorstep to screen for fever • Maintaining a hospital visitor log to allow for
Dissemination of information to HCW	1. A robust system of dissemination of information (changing policies, workflows, etc.) 2. Email and meetings alone are insufficient to operationalize urgent changes on the ground 3. Clinical discussions of confirmed cases within the ICU community	• Utilization of secure and approved platforms such as institutional email and messaging applications to inform various job groups and teams of rapidly evolving workflows and policies • Utilization of secure videoconferencing applications to hold inter-institution and inter-department meetings and educational sessions • Utilization of secure and approved applications such as messaging and videoconferencing applications to conduct clinical discussions of cases and the sharing of experience
Resuscitation and code blue response	1. Provide clear guidelines on personal protective equipment and use of powered air-purifying respirators in ISO wards and normal wards during resuscitation 2. Provide inter-professional simulation of resuscitation scenarios for suspected or confirmed cases	• Simulation practice with personal protective equipment and use of powered air-purifying respirators will help identify gaps in the wards and prepare ISO teams for such scenarios • Simulation with limited team members per scenario, for example, 4 members per team, to allow acclimatization of HCW to perform resuscitation in smaller teams • Checklists for preparation of drugs and pre-prepared trolleys for equipment, for intubation, line setting, and other procedures, to minimize staff movement and enhance efficiency • Creative ways to improve communications during resuscitation, such as the utilization of a printed "Call Airway Team" card for difficult intubations, using a communication whiteboard in the patient room and using walkie-talkies to relay messages to staff outside the room for equipment and help

Issues	Principles	Solutions
Advanced ICU services	1. To provide clear thresholds for transfers of deteriorating cases for extracorporeal membrane oxygenation (ECMO) 2. To provide efficient and safe delivery of ICU bronchoscopy	• Early transfer of deteriorating cases is recommended. Provision of thresholds for transfer and workflows for non- extracorporeal membrane oxygenation (ECMO) centers • Use of disposable bronchoscopes for bronchoscopy and percutaneous tracheostomy
Psychological stress and burnout of HCW	1. To provide emotional support, encouragement, and appreciation to HCW 2. Reduce stigmatization of HCW by ill-informed members of the public	• A special provision of meals and drinks to boost morale; laundry service for used scrubs • Provision of regular updates of the local situation and status by the government and institution leadership • Frequent encouragement of HCW by divisional heads and senior leaders via emails, messaging apps and social media platforms, allowing staff to remain engaged • Timely articles and courageous stories of frontline staff • Appropriate media coverage of HCW at the frontline to increase empathy and reduce stigmatization

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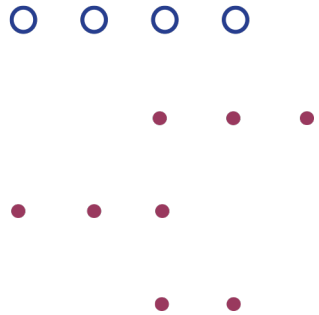

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