

Special Article

Flattening the Curve on COVID-19: South Korea's Measures in Tackling Initial Outbreak of Coronavirus

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The spread of coronavirus disease 2019 (COVID-19) is causing an unprecedented crisis around the world, with South Korea being no exception. South Korea experienced a surge of COVID-19 cases on February 19, 2020, but was able to flatten the COVID-19 curve in only 20 days without enforcing lockdown measures that restrict the freedom and movement of people. The actual field experience of the Korean government's COVID-19 response team, who participated in drafting the document "Tackling COVID-19: Health, Quarantine, and Economic Measures: Korean experience," was examined and an in-depth analysis was conducted of the South Korean government's experience dealing with the Middle East respiratory syndrome of 2015. Three prominent factors were identified behind Korea's responses against COVID-19. First, it was crucial that the government responded as 1 team efficiently to cooperate and respond to COVID-19. Second, a novel approach was needed to combat COVID-19 spread. Information and communication technology had a key role in South Korea's strategy to contain COVID-19. Third, an effective response to COVID-19 was possible due to the successful partnership between the general public and state authorities.

contact tracing; COVID-19; epidemiologic investigation; MERS; South Korea

Abbreviations: CDSCH, Central Disaster and Safety Countermeasures Headquarters; COVID-19, coronavirus disease 2019; ICT, information and communication technology; KCDC, Korea Centers for Disease Control and Prevention; MERS, Middle East respiratory syndrome.

On February 29, 2020, the number of new positive cases of coronavirus disease 2019 (COVID-19) surged to 909 in South Korea (1). This was the worst COVID-19 outbreak outside of China at that time (2, 3). However, the South Korean government did not impose strict lockdown measures on personal movement or airport shutdowns. Two weeks later, on March 15, the number of new positive cases dropped to 76. South Korea has slowed the spread of COVID-19 and flattened the curve of new infections without taking extreme measures that restrict the movement of people and core businesses (Figure 1) (1, 4).

The purpose of this study was to examine the South Korean government's response to the initial outbreak of COVID-19 from February to May 2020. In particular, we examined how South Korea flattened the COVID-19 spread-of-infection curve without enforcing a lockdown, even after

the virus was widely dispersed at the community level. The study is based on the actual on-site experience of members of the South Korean Ministry of Economy and Finance's COVID-19 response team. We examined previous responses to the Middle East respiratory syndrome (MERS) in 2015 and analyzed the changes made in combatting the spread of epidemics at the national and local levels (5).

EPIDEMICS AND COVID-19

With the spread of COVID-19, the world is facing unprecedented economic and health crises (6). Many global leaders see COVID-19 as the gravest challenge the world has faced since World War II (7). Current academic research on COVID-19 focuses primarily on health, quarantine, and medical research. Given that COVID-19 continues to

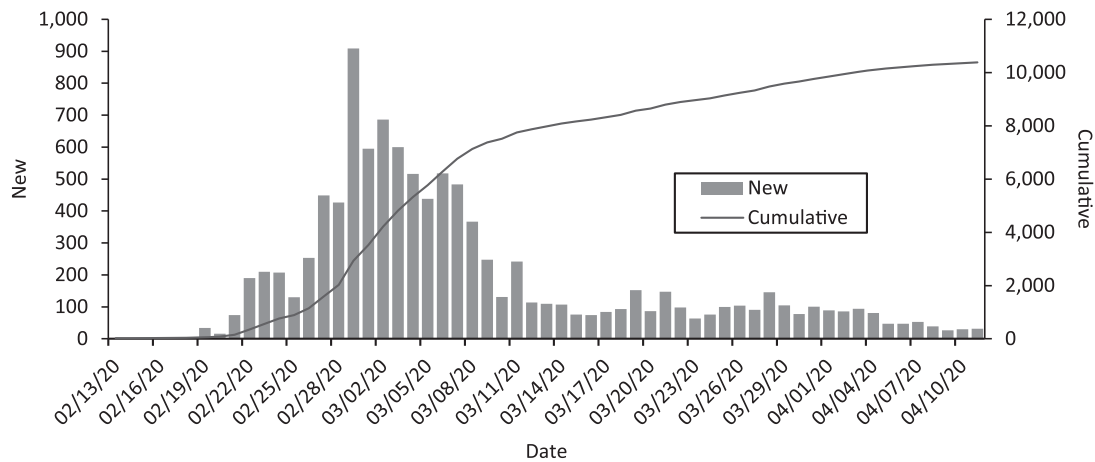


Figure 1. New and cumulative cases of coronavirus disease 2019 (COVID-19) in South Korea from February 13, 2020, to April 11, 2020 (8). South Korea recorded 909 COVID-19 cases as of February 29, 2020, which was the worst outbreak outside of China at that time (2, 3). But South Korea flattened the outbreak curve, with only 76 new cases on March 15, 2020.

diffuse and affect the lives of people around the world, we focused on government policy measures to tackle the highly infectious virus at the initial outbreak stage.

Many countries are endeavoring to identify the most effective response to contain COVID-19 at the national level by imposing a temporarily lockdown of selected cities or the entire state and declaring a total ban on foreigners entering the country. Meanwhile, the South Korean government chose to maintain the existing health, quarantine, and immigration procedures without implementing lockdown measures. COVID-19 in South Korea is currently controlled only by containment and mitigation measures (8). South Korea has become a unique case in maintaining mitigation measures from the beginning of COVID-19. As such, it can be a guiding case for countries currently exposed to COVID-19 that have not taken any containment measures at an early stage (9). We present 3 factors that contributed to flattening the curve of COVID-19 from historic, quarantine, and implicit contexts.

EVOLUTION FROM PREVIOUS EPIDEMICS

The successful response and control of the COVID-19 outbreak evolved from lessons learned from previous outbreaks, especially MERS in 2015. MERS is a respiratory illness that was first reported in 2012 in Saudi Arabia (10). South Korea experienced a significant MERS outbreak in 2015 when a total of 186 confirmed cases, including 38 associated deaths, were reported (11). South Korea suffered the worst damage outside of the Middle East. Table 1 presents the lessons learned from the MERS crisis (12). After the MERS outbreak, South Korea strengthened the functions of its central disease control headquarters, the Korea Centers for Disease Control and Prevention (KCDC), and implemented major changes in the hospital infection control system, the emergency medical service system, and the enhanced nursing system to reduce and prevent infec-

tions in hospitals and health-care facilities. The most extensive health and quarantine reform was seen in the reduction of infection among health-care workers in hospitals and health-care facilities.

TACKLING COVID-19

Without resorting to blockades, lockdowns, and the suspension of public transportation or other large-scale restrictions, South Korea has maintained people's day-to-day freedoms with minimal interference in their movement, even at the height of the COVID-19 outbreak. The heart of this strategy consists of agile and comprehensive testing to identify positive cases, robust tracing of their contacts to prevent further spread, and rigorously treating those infected at the earliest stage possible (13, 14). In the following paragraphs, we describe how South Korea responded to COVID-19 with the 3Ts strategy: testing, contact tracing, and treatment.

Governance and institutions

Figure 2 shows how COVID-19 response intergovernmental task forces share responsibilities (1). Since raising the national infectious disease alert level to serious (on February 23, 2020), the South Korean government has assembled the Central Disaster and Safety Countermeasures Headquarters (CDSCH), headed by the Prime Minister, to double down on government-wide responses to COVID-19. The Prime Minister chairs the CDSCH meeting, which comprises all relevant ministries of the central government as well as the 17 provinces and major cities. Given the specialty and expertise required in the infectious disease response, the KCDC serves as the command center of the prevention and control efforts. The Vice Head 1 of the CDSCH, who also serves as the head of the Central Disaster Management Headquarters (Minister of Health and Welfare), assists the KCDC (headed by the director of the KCDC). The Minister

Table 1. Lessons Learned from the Middle East Respiratory Syndrome Outbreak in South Korea in 2015^a

Area	Lessons Learned
Public health governance	Clear roles and responsibilities between the central and local governments via the Central Disease Control Headquarters Robust coordination structure between the health and medical authorities
Contact tracing	Accurate epidemiologic investigations of the first confirmed case New legal standards for scope of close contacts
Health-care systems	Proper government management of medical institutions and hospitals Medical staff from the local health centers National research spending in epidemic diseases
Communication	Quick and accurate relay of information to the general public

^a Data from the Korean Ministry of Health and Welfare (12).

of Interior and Safety, head of the pan-government Countermeasures Support Headquarters, assumes the role of Vice Head 2 of the CDSCH to provide necessary assistance, such as coordination between the central and local governments. Each local government established a local disaster and safety management headquarters led by the heads of the local governments to secure an adequate number of infectious disease hospitals and beds. If the countermeasure required is beyond the capacity of local governments, the central

government may supply the necessary resources, including beds, personnel, and supplies.

Taking lessons from the past MERS outbreak, the status of the KCDC was upgraded to a vice minister-level organization (15). The crisis management manual was revised in June 2016 so that the head of the KCDC can lead the quarantine regardless of the level of the alert stage. The KCDC also receives various types of assistance, such as those from Minister of Health and Welfare. The Minister of the Interior

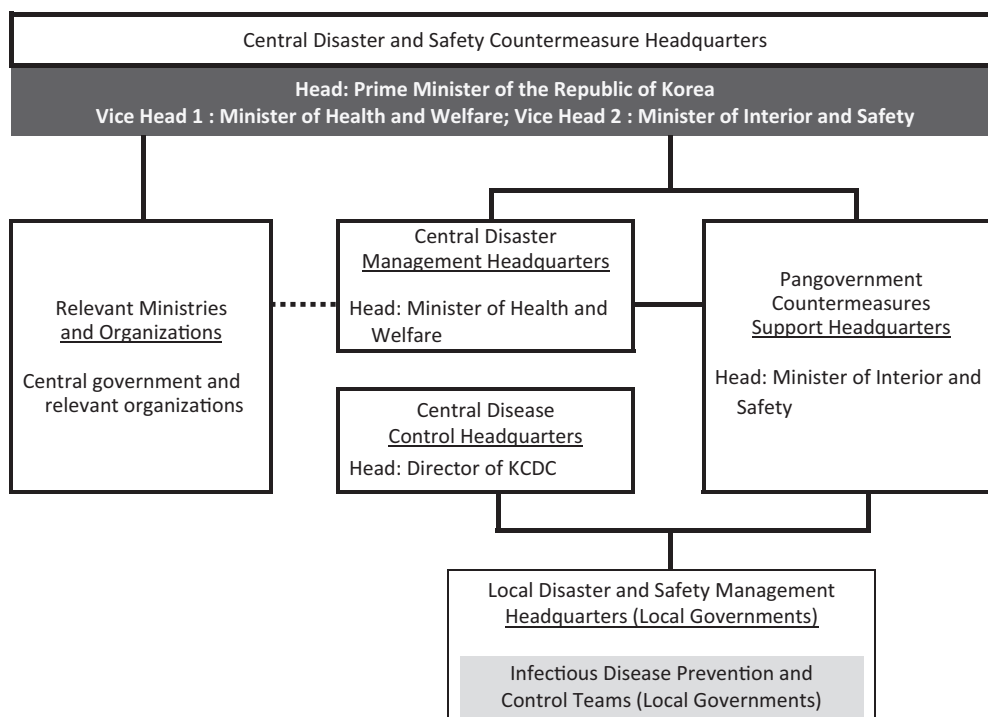


Figure 2. The response systems of the South Korean government to coronavirus disease 2019 (COVID-19) (1). Under the umbrella disaster management organization, the Central Disaster and Safety Countermeasure Headquarters is headed by the prime minister, and various central and local government organizations respond to COVID-19.

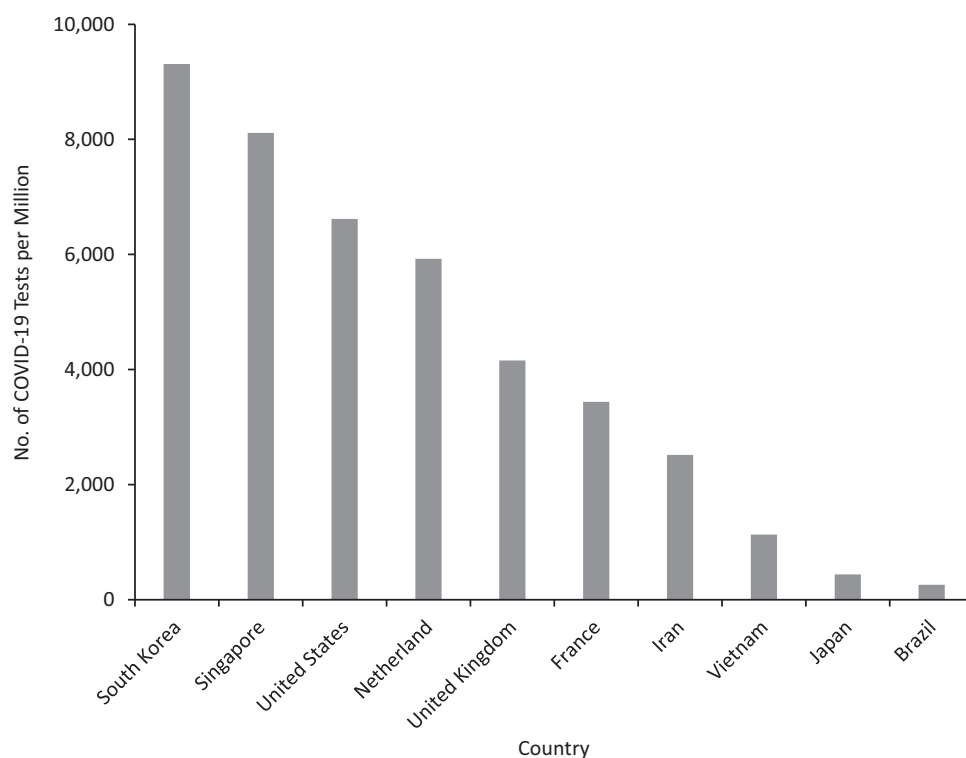


Figure 3. This figure describes the number of coronavirus disease 2019 (COVID-19) tests per million in the listed countries as of April 8, 2020 (1, 18). South Korea tested 9,310; Singapore, 8,113; the United States, 6,615; the Netherlands, 5,926; the United Kingdom, 4,155; France, 3,436; Iran, 2,514; Vietnam, 1,131; Japan, 437; and Brazil, 258. South Korea conducted the most COVID-19 tests among these 10 countries as of April 8, 2020.

and Safety took the role of the director of the government-wide Countermeasures Support Center connecting the central and local governments. The central government provides assistance in terms of hospital beds, personnel, supplies, and in other areas where local governments face shortages. This close partnership between the central and the local governments, along with a strengthened capacity to control epidemic diseases at the local government level, is an important consequence of the MERS experience (16).

Agile and comprehensive testing system of COVID-19

The South Korean government conducted an impressive number of tests within a short time to diagnose potential COVID-19 cases and to block the spread of the virus as early as possible. This became possible due to an amendment to the law that allows for prompt testing and diagnosis by local public health centers and private hospitals along with the KCDC, the National Medical Center, and the National Institute of Health. As of April 8, 2020, a total of 486,003 tests had been conducted. As shown in Figure 3, Korea's COVID-19 testing performance is higher than that of Japan, Vietnam, and Singapore (1, 16). South Korea turned to a network of public and private laboratories to develop tests. On February 4, 2020, the South Korean government granted a fast-track approval of 1 company's COVID-19 test and began shipping

the kits. A second company's test was approved a week later, and 2 more soon followed.

The South Korean government set up screening centers at public health centers and health-care institutions to ensure easy access to diagnostic testing. It also diversified their operating models to respond more effectively to the increasing demand for diagnostic testing. The South Korean government is collecting testing specimens through more than 50 drive-through screening centers, mobile facilities, and door-to-door visits to ensure greater efficiency and safety (1, 17, 18). For the purposes of testing and managing COVID-19, there are 3 type of cases: confirmed cases, suspected cases, and patient-under-investigation cases, as indicated in Table 2 (1, 14). Currently, a diagnostic test for COVID-19 is conducted if the person has had contact with confirmed COVID-19 cases, has been released from self-quarantine, has had close contact with people suspected to have COVID-19, and or has had symptoms of an unknown respiratory disease (1, 14, 18).

South Korea's COVID-19 testing is processed within 6 hours. First, the testing begins by collecting specimens from those suspected of being infected, using 3 testing methods: nasopharyngeal swab, oropharyngeal swab, and sputum collection. Second, the collected specimens are packaged in triplicate and transported to a government-certified testing center. Third, the transferred specimen is subjected to an

Table 2. Three Types of Coronavirus Disease 2019 Cases in South Korea^a

Type	Description
1: Confirmed case	A person who has tested positive for COVID-19 in accordance with testing standards, irrespective of clinical signs and symptoms
2: Suspected case	A person with a fever ($\geq 37.5^{\circ}\text{C}$) or respiratory symptoms (e.g., coughing, difficulty breathing) within 14 days of suspected contact A person who is suspected of having the COVID-19 per a doctor's diagnosis of pneumonia due to unknown causes, <i>OR</i>
3: Person under investigation case	A person with a fever ($\geq 37.5^{\circ}\text{C}$) or respiratory symptoms (e.g., coughing, difficulty breathing) within 14 days of traveling to a country with local transmissions of COVID-19, such as China, <i>OR</i> A person with an epidemiologic link to the collective outbreak of COVID-19 with a fever ($\geq 37.5^{\circ}\text{C}$) or respiratory symptoms within 14 days

Abbreviation: COVID-19, coronavirus disease 2019.

^a Data from the Korean Ministry of Health and Welfare (12).

acceptance procedure. Fourth, to engage the testing, the genetic material (i.e., the nucleic acid) must be extracted from the specimen. This work is performed by clinical pathologists in a negative-pressure room and usually takes approximately 90 minutes. Fifth, real-time reverse transcription–polymerase chain reaction, a technique that can confirm the amount of DNA amplification in real time, is used. This process takes approximately 2 hours. Sixth, when the augmentation reaction is over, the diagnostic specialist takes 30 minutes to analyze and read the results. Finally, the results are reported as positive, negative, or indeterminate (or undecided) and retested if necessary (1, 14, 19, 20).

Robust contact tracing system of COVID-19

The South Korean government is undertaking vigorous measures to trace those who were in contact with confirmed patients, by tracking down their credit card transactions, closed-circuit television recordings, and global positioning system data on their mobile phones, when necessary. Anonymized information is disclosed to the public so those who were in the vicinity of confirmed patients will go through the testing themselves. Those identified through epidemiologic investigations are instructed to self-quarantine and monitored 1-on-1 by staff of the Ministry of the Interior and Safety and local governments. The swift response to the May outbreak in Seoul's nightclub district was also possible through rigorous contact tracing. After lifting strict social distancing measures in May, South Korea saw a surge in COVID-19 cases on May 2 linked to nightclubs, which resulted in a total of 277 new cases (1). The health authority asked all who had visited the clubs at that time to get tested, but there was very low turnout, due to fear of unwanted attention and social prejudice against lesbian, gay, bisexual, and transgender groups. The nightclub incident in Korea confirmed that contact tracing is difficult to achieve when relying solely on the voluntary participation of citizens.

The South Korean government devised 5 steps in handling newly confirmed cases (1). First, upon identifying a

patient with newly confirmed COVID-19 (including deaths), local public health centers immediately report the case to the KCDC and register the case in the Integrated Systems for Disease and Health portal. Meanwhile, any confirmed case through a positive test must be registered on the same day.

Second, if a public health center finds that a confirmed patient needs to be isolated immediately, this is done so in their home, a treatment support center, or hospital. The public health center categorizes the severity of the confirmed patient as mild, moderate, severe, or highly severe by measuring the patient's level of consciousness, body temperature, and health risk factors. Those placed in the moderate, severe, or highly severe categories are transferred to a hospital for isolation. Patients with a mild case who do not meet the criteria for hospitalization are isolated and monitored in their home or at a treatment support center.

Third, the South Korean government conducts in-depth epidemiologic investigations into confirmed patients to identify spreaders of the virus and their movements. The investigation is jointly conducted by the KCDC Rapid Response Team and the local government epidemiologic investigation team. The investigation period lasts 10 days (incubation period, +3 days) before the occurrence of symptoms in the confirmed patients. The investigation includes details of the patient's daily movements and identifies those with whom they have had physical contact over the previous 10 days, by interviewing the patient, reviewing medical records, tracking closed-circuit television recordings, credit card use, and immigration information to secure as much information as possible. Family members, housemates, and other contacts identified by epidemiologic investigation of the patient's travel and infection routes are put under self-quarantine for the maximum incubation period of 14 days, beginning from the day after the date of contact, and are monitored on 1-on-1 by assigned public health officials. On March 26, 2020, the government launched the COVID-19 epidemiologic Investigation Support System, a centralized

Table 3. Methods of Epidemiologic Investigation^a

Method	Description
Interview	An epidemiology investigation is done mainly by conducting an interview in person. However, if this is not possible, an interview may be conducted with family, travel companions, or acquaintances.
Medical history records	Additional information may be obtained through patient care, interviews with nursing personnel, and access to all medical records.
Closed-circuit television	If necessary, images and detailed data of the patient's circulation and movement path may be requested.
Credit card and transportation	If necessary, the route of transportation, credit card, debit card, or prepaid card statements may be requested.
Immigration	If necessary, immigration records may be requested and checked.
Hospital records	If necessary, health insurance inquiries may be made to check if there is a history of visiting or using medical institutions.

^a Data from the Korean Centers for Disease Control and Prevention (1).

data collection and multiagency coordination platform. The system has upgraded the method of contact tracing from manual analysis by epidemiologic investigators to automatic analysis, thus significantly reducing the time needed for each case analysis from 24 hours to 10 minutes. Table 3 details the different approaches of epidemiologic investigation (1).

Finally, the criteria for release from quarantine must meet 2 criteria. The first is that confirmed patients should show improvement of clinical symptoms, such as having no fever without taking antipyretics. The second is that confirmed patients should have 2 negative results of body temperature tests taken at a 24-hour interval.

Rigorous treating system of COVID-19

The establishment of a patient management system. South Korea expanded its infrastructure of infectious and epidemic disease treatment facilities after the MERS crisis. Through an amendment to the law, the government appointed hospitals specializing in epidemic control and prevention in each central and provincial government. Accordingly, the Emergency Medical Act was amended in December 2016 (11). The measure was to secure screening and isolation facilities for patients suspected of having infectious diseases. Isolation beds in negative-pressure rooms were secured by strengthening the standards of hospitals and medical institutions. In September 2016, a control and prevention management fee for infectious diseases was added to insurance premiums (11). The service compensates the money spent on treatment materials for the prevention of infection and strengthens the evaluation criteria of hospitals and medical institutions in infection control and prevention.

The South Korean government is classifying patients on the basis of severity and accommodating them accordingly at hospitals or living and treatment support centers according to the aforementioned criteria. The National Medical Center

coordinates patient transfers between cities and provinces when patient beds are in short supply in certain regions (Table 4) (1).

Patients with mild symptoms are isolated at living and treatment support centers and are monitored by health-care staff at least twice per day to be readily transferred to health-care institutions if symptoms worsen or to be discharged on the basis of relevant standards when symptoms are mitigated (in approximately 3 weeks). City and provincial governments designate government-run facilities or lodgings as living and treatment support centers, and provide a relief kit (e.g., underwear, toiletries, masks) and a hygiene kit containing a thermometer and medicine (Table 5) (1).

To support patient care and infection control for different regions, the South Korean government is aggressively recruiting health-care specialists through different channels, such as requesting staff members from other institutions and stationing them at health-care institutions in need, which are mainly based in Daegu City and Gyeongbuk Province. To secure additional health-care staff, the government posted an urgent recruitment announcement for doctors, nurses, clinical pathologists, and field safety managers for the treatment of patients with COVID-19. In addition, the South Korean military provided active medical support by dispatching 300 military doctors and nursing officers. Thus far, 750 new public doctors have been appointed and stationed. Meanwhile, nurses are continually being recruited. After caring for patients with COVID-19, health-care workers are not required to self-quarantine. If a health-care staff member wishes to self-quarantine, the government puts them under paid (65%–75% of the normal work salary) self-quarantine for 2 weeks to protect them, and replaces them with another member of staff, thus providing infection control services as well as financial compensation. Furthermore, the South Korean government has distributed its reserves of protective equipment to local governments and government-designated

Table 4. Patient Management System of South Korea^a

System	Description
Treatment system ^b	
Mild case	Isolated and monitored at residences or treatment support centers
Moderate, severe, and extremely severe case	Immediately hospitalized for treatment
Hospital bed system	Beds at government-designated institutions for hospitalized treatment, regional hub hospitals, and infectious disease hospitals are allocated to confirmed cases. 60 infectious disease hospitals designated Continually securing additional beds
Health-care staff system	Recruiting health-care specialists via a range of channels and methods Protecting health-care staff by self-isolation, infection control services, and financial compensation Distributing government reserves of protective equipment to local governments and government-designated institutions for hospitalized treatment
Medicinal supplies system	Supplying management with empirical therapies and sharing distributor information Clinical testing and research of vaccines in collaboration with the private medical partners

^a Data from the Korean Centers for Disease Control and Prevention (1).

^b Patients were classified into 4 categories on the basis of severity: mild, moderate, severe, and extremely severe (1).

institutions for hospitalized treatment, with priority given to Daegu City and Gyeongbuk Province.

Realignment of the health-care institution use system. The South Korean government is trying to ensure hospital accessibility and safety for patients without COVID-19 by designating separate areas for respiratory patients and nonrespiratory patients. As of March 27, 2020, 337 hospitals

were designated nonrespiratory diseases hospitals in which patients with COVID-19 were not treated. In addition, the government has permitted nonrespiratory patients to receive counseling and prescriptions by phone or proxy to prevent the spread of infection within health-care institutions. Patients with pneumonia are put through diagnostic testing before entering an intensive care unit, so confirmed cases can be detected before they lead to infection. Patients with

Table 5. Response Procedures for Suspected Cases and Persons Under Investigation Cases^a

Response	Suspected Case	Person Under Investigation
Occurrence report	First recognizing agency (medical institution/public health center)	First recognizing agency (medical institution/public health center)
Specimen collection	Screening clinic	Screening clinic or medical institution
Authority in charge	Local epidemiologic agency	Screening clinic or medical institution
Treating method	Self-isolation/treating center ^b	Health education
Patient transfer	Own car/on foot/ambulance	Refrain from public transportation
Quarantine notice	Verbal or written notice	
Quarantine release	Local epidemiologic agency	
Financial support	Testing and quarantine costs	Testing cost only

^a Data from the Korean Centers for Disease Control and Prevention (1).

^b Prior to notification of test results, the institution that performs the evaluation and testing will provide basic guidance regarding transportation, public health education, and so forth (1).

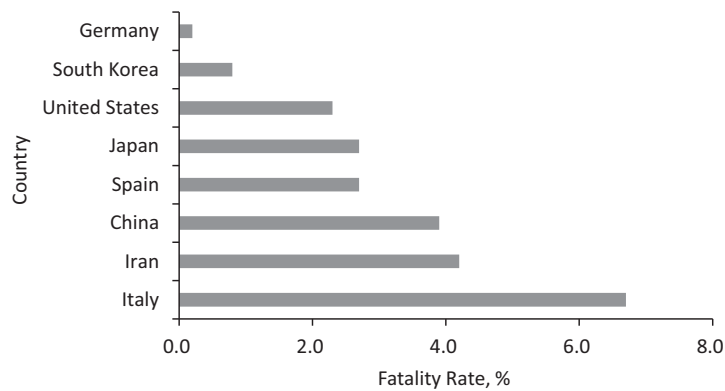


Figure 4. The coronavirus disease 2019 (COVID-19) fatality rate among the listed major countries for COVID-19 infection as of April 8, 2020 (1, 19). A fatality rate means the number of deaths divided by the number of confirmed cases. Germany had a 0.2% fatality rate; South Korea, 0.8%; the United States, 2.3%; Japan and Spain, each 2.7%; China, 3.9%; Iran, 4.2%; Italy, 6.7%. South Korea had the second-lowest fatality rate as of April 8, 2020.

suspected infection are required to undergo testing in a separate area before being allowed to enter the emergency center.

To reinforce infection control within health-care institutions, the South Korean government is providing infection control guidelines to health-care institutions and focusing on expanding cooperation and communication in health-care circles. Health-care institutions are required to provide patients with guidance on hygiene, restrict the entry of visitors, adhere to visiting conditions, check each visitor's body temperature, and mandate the wearing of masks. Staff members must wear masks while on duty and immediately report to public health centers if a patient falls into any of the predefined categories. Staff members are excused from work for 14 days if they show any signs of illness.

THREE PREREQUISITES TO FIGHT COVID-19

In response to the COVID-19 outbreak, it is important for governments to have well-functioning health-care governance to implement the test-trace-treat capabilities. If a country emulates South Korea's response against COVID-19, it can successfully overcome the virus and reduce the number of fatalities (Figure 4) (1). Active testing, epidemiologic investigation of confirmed patients, and effective treatment are crucial to curbing COVID-19, but there are important prerequisites in the medical, industrial, technical, and political areas that are required. South Korea's response to COVID-19 requires a good understanding of 3 basic requirements (1).

First, it is crucial that the government responds quickly to the spread of COVID-19. In the case of South Korea, more than 20 experts in the field of infectious diseases gathered in a conference room in Seoul on January 10, 2020, to discuss matters. It was at the time when the cause of the cluster of pneumonia cases reported in Wuhan, China, was still unknown to the outside world. Until then, no deaths resulting from COVID-19 were reported in China. South Korean experts discussed methods to secure the country's diag-

nostic capabilities for novel COVID-19. In early February, the South Korean government approved COVID-19 testing kits promptly. In addition to South Korean health authorities, various government agencies have been cooperating organically and efficiently to respond to COVID-19 as 1 team (1).

Second, 1 of the secrets to South Korea's responses to COVID-19 is that the country has a high level of information and communication technology (ICT) capabilities. A novel approach is needed to combat the spread of the novel virus. South Korea possesses the latest ICT capacities and infrastructure. In particular, South Korea is a leader in high-speed internet, 5G mobile network, and optical cable penetration. South Korea responds to COVID-19 by using various and innovative ICT technologies, including COVID-19 infection tracking, testing, the dissemination of patient movement information, the identification of infected contacts, and smartphone self-quarantine and self-diagnosis applications. Through these ICT capacities and infrastructure, epidemiologic investigators have automated the collection, processing, and analysis of contact tracing information and significantly reduced the time needed for each case analysis from 24 hours to 10 minutes (13).

Third, an effective response to COVID-19 was possible because of the successful partnership between the general public and state authorities. South Korea has avoided the phenomenon of panic buying since the emergence of COVID-19. South Koreans voluntarily wore masks to reduce the possible spread of the disease and also voluntarily underwent COVID-19 testing once they were informed of having had contact with people infected with the virus. Without this mature sense of citizenship, South Korea's measures against COVID-19 could not have delivered such successful outcomes.

CONCLUSION

In this article, we have discussed the COVID-19 outbreak in South Korea from January to April 2020 and the health

and quarantine responses of the South Korean government. After peaking at 909 cases on February 29, 2020, the number of new cases per day has steadily decreased to double digits, starting from March 15, and eventually to single digits on April 19. The case of South Korea provides policy implications for health and quarantine experts and government officials around the world that are useful in responding to the initial COVID-19 outbreak and flattening the virus-spread curve. However, there are also clear limitations of South Korea's response. The South Korean approach to COVID-19 may be difficult to emulate even for countries with advanced health and medical institutions and professionals, like the United States and the United Kingdom, but it provides important policy implications for developing countries and needs for strengthening 3 core competencies.

First is the swift action in response to COVID-19. Just 1 week after the first case was confirmed in South Korea on January 27, 2020, government officials summoned representatives of major medical companies. By the end of January, the KCDC had approved 1 company's diagnostic testing kit. A testing kit of another company was also approved soon after. The second action can be summarized as the 3Ts: 1) agile testing, 2) contact tracing, and 3) rigorous treating. As of April 12, South Korea had identified more than 10,512 confirmed cases of COVID-19 by testing 514,621 people (21, 22). The third action is public-private cooperation and civic awareness. The high level of civic awareness and voluntary cooperation, such as adhering to personal hygiene measures including wearing of face masks, observing self-quarantine measures, and maintaining social distancing, are crucial factors in fighting against COVID-19.

COVID-19 is an ongoing pandemic. Many countries still have not tackled the initial outbreak, and most are still enforcing high levels of social distancing and lockdown measures. Meanwhile, some countries are concerned about the upcoming second wave. It could be said that we might be sleeping with the invisible enemy for quite a long time to come. In this regard, additional research on the COVID-19 response to the following topics seems both relevant and necessary.

The first issue is contact tracing and the protection of privacy. In South Korea, digital contact tracing was possible after the 2015 MERS outbreak through a revision to the Contagious Disease Prevention and Control Act (23). The revised Act overrides certain provisions of the Personal Information Protection Act and other privacy laws and gives sweeping power to authorities to collect, profile, and share personal location information for epidemiologic investigation. However, most countries do not have this legal framework nor power, due to the protection afforded to privacy. After COVID-19, the issue of finding a suitable balance between the collection of personal information and the protection of the privacy of an infected individual will become important in the academic, political, and political agendas of many countries.

The second issue is the reopening of the economy and the loosening of social-distancing measures. Strong lockdown and social-distancing measures have been successful in limiting the spread of COVID-19 and flattening the curve. However, there are significant economic, social, and politi-

cal costs and consequences. The global economy expects to face its biggest crisis since World War II (24). In countries that have recently relaxed social distancing, the spread of COVID-19 is again on the rise. So now, many are asking when and how can we reopen our economies and get back to normal life?

The third issue is preparing for the second wave of COVID-19. In South Korea, the average number of new cases per day had fallen to 6.4 in the first week of May with strong social distancing and adherence to the 3Ts. However, after the loosening of social distancing, the average number increased again to 43.6 in the last week of May and the first week of June, with a small outbreak at the regional level. Anticipation of the second wave of COVID-19 will remain a major concern for all countries for the time being.

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