Interim Evaluation of South Korea's Response to COVID-19 and Preparation for a Post-COVID-19 World in Public Health

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Abstract: The aims of this study are to describe the key success factors of South Korea's response to COVID-19 and to prepare for the post-COVID-19 world in public health. The MERS-CoV outbreak in 2015 provided the country with opportunities to enhance its national public health capacity in responding to emerging diseases, particularly in the areas of governance, testing, and tracing strategies, public-private partnership, risk communication, and the legal system supporting the government's actions. This newly established system played a key role in South Korea's relatively successful response to COVID-19. In this study, I evaluate that response and propose public health policies with a view to preparing for the post- COVID-19 world.

Keywords: COVID-19, public health policies, governance, public-private partnership

INTRODUCTION

In the latter half of 2020, South Korea's agile response to the COVID-19 pandemic became the subject of global interest. In the COVID-19 webinar on 20 July, South Korea's response was described as one of the best, together with Germany and Vietnam. One of key factors for South Korea's relative success in is the lessons learned from the MERS-CoV outbreak in 2015, which prompted changes in the national public health response system in areas of governance, testing and tracing strategies, public-private partnership, risk communication and the legal system supporting the gov-

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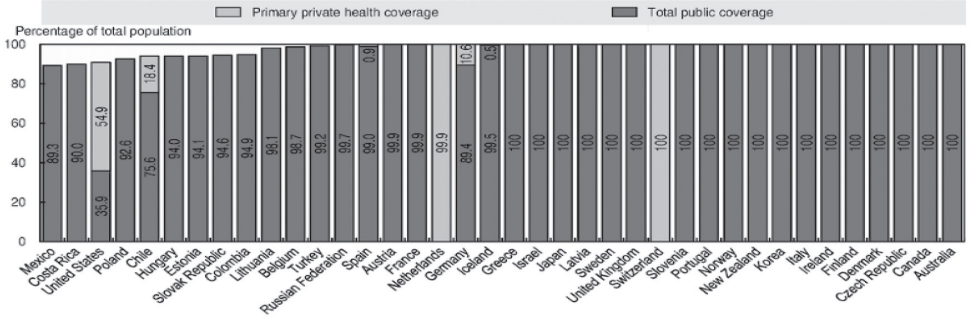
ernment's strategies. In one of many studies that were published in the wake of MERS-CoV outbreak in Korea, Jiyoun Chang (2017) proposed developing more network-type approaches to managing disasters such as a crisis communication channel and information-sharing systems. Other factors in the success of Korea's response to COVID-19 that have been cited include a strong central government tradition, a docile and order-minded citizenry, and even the country's Confucian culture, especially when it comes to the extensive process of contact tracing.

In this article, I briefly describe the changes the government made to the national public health response system after the MERS-CoV outbreak in Korea and use the current COVID-19 crisis to point to more immediate and easily identifiable institutional factors and behavioral features that have contributed to Korea's success in handling the pandemic, offer an interim evaluation of Korea's response, and make proposals for how to manage the post-COVID-19 world in public health.

THE HEALTH SYSTEM AND COVID-19 RESPONSE IN SOUTH KOREA

The COVID-19 crisis has proven the critical importance of universal health coverage, which ensures people's access to testing and treatment options including hospital facilities and infrastructures in the case of emergencies arising from new infectious diseases with imposing financial burdens on them. Yet, as figure 1 shows, even countries with 100% coverage for core sets of health services have suffered from the COVID-19 crisis. Korea's successful strategy went beyond 100% coverage; it also included extensive contact tracing, isolation and quarantine, and early treatment made possible by proactive testing.

Figure 1. Population Coverage for a Core Set of Services (late 2010s)



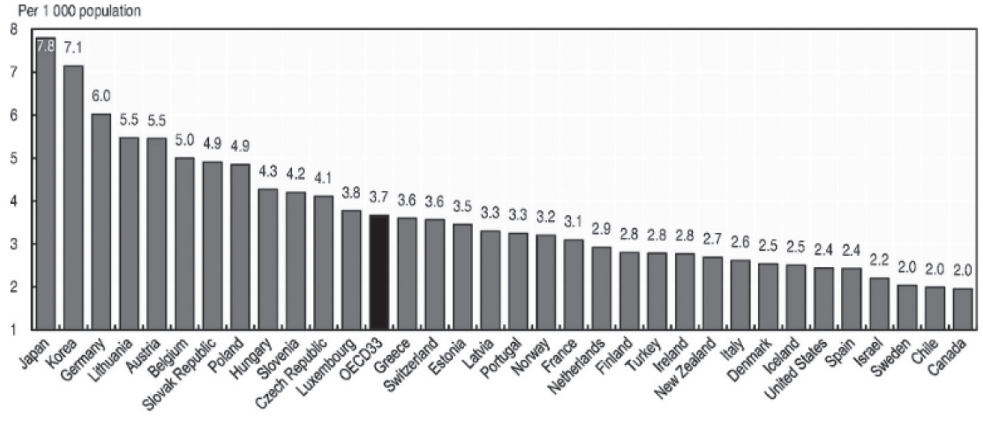
Source: OECD Health Statistics 2019, https://doi.org/10.1787/health-data-en.

Medical Infrastructure

South Korea has 362 general hospitals, 1,628 hospitals, 1,704 nursing hospitals, 21 military hospitals and more than 30,000 clinics, with 12.3 hospital beds per 1,000 people. It has the second largest number of hospital beds per 1,000 people and the second largest number of acute care hospital beds (figure 2). Among 3,937 hospitals nationwide, 224 (5.7%) are public hospitals, whose beds make up 10% of total hospital beds. In addition to the 224 public hospitals, there are 256 public health centers, 1,340 public health center branches, 1,904 public health clinics, and 64 health promotion centers.

Means of responding to acute infectious diseases, including negative pressure rooms, intensive care units (ICU), and triage systems, were strengthened after the MERS outbreak in 2015. Since then, the country has established 598 triage centers and 1.2 negative pressure rooms per 100,000. During the peak of the COVID-19 outbreak in February and March 2020, 1,077 negative pressure rooms were in operation. Nevertheless, the number of ICUs per 100,000 people in South Korea (10.6) is below the OCED average of 12.0 (figures 2 and 3).

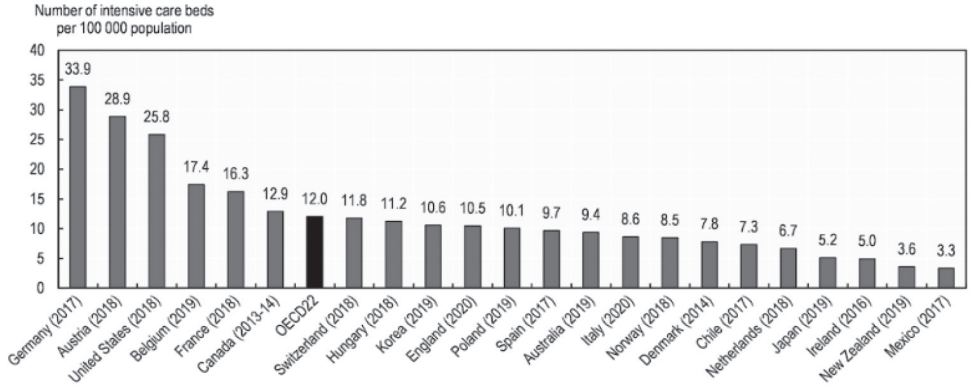
Figure 2. Acute Care Hospital Beds in OECD Countries per 1,000 People (Late 2010s)



Note: Acute care beds include not only beds in intensive care units, but also beds in acute care units (e.g. all surgical units, all gynaecological and obstetric services, as well as acute psychiatric care beds in about half the countries). France, Japan and Latvia exclude psychiatric care beds.

Source: OECD Health Statistics 2019, https://doi.org/10.1787/health-data-en.

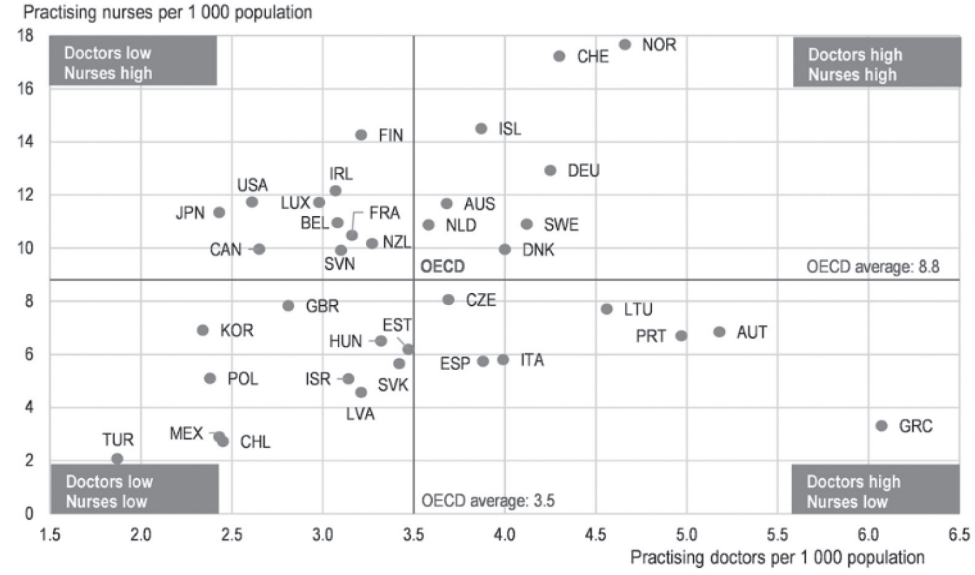
Figure 3. Number of Intensive Care Beds in Selected OECD Countries per 100,000 People (Late 2010s)



Source: OECD Health Statistics 2019, https://doi.org/10.1787/health-data-en

As Figure 4 indicates, the number of health care professionals, namely nurses and doctors, in South Korea is relatively low among the OECD countries.

Figure 4. Density of Doctors and Nurses in OECD Countries per 1,000 People (Late 2010s)



Note: In Portugal and Greece, data refer to all doctors licensed to practice, resulting in a large overestimation of the number of practising doctors (e.g. of around 30% in Portugal). In Austria and Greece, the number of nurses is underestimated as it only includes those working in hospital.
Source: OECD Health Statistics 2019, https://doi.org/10.1787/health-data-en

In 2017, 120,630 doctors (2.3 per 1,000), 35,980 pharmacists (0.7 per 1,000) and 355,524 nurses (6.9 per 1,000) were working in health facilities across Korea. Unlike the number of hospital beds per 1,000 people in Korea, the number of doctors per 1,000 people is low among the OECD countries.

All South Koreans except the lowest-income group enroll in the compulsory national health insurance, whom health care providers must treat. The lower-income group can still receive health care services without making a contribution to the national health insurance plan. Private hospitals, which account for 94.3% of all hospitals, as well as public hospitals are operated by the national health insurance system.

The national health insurance system has been key to providing universal health coverage for the whole population and easy access to high quality medical care throughout COVID-19 crisis. From day 1, the government enabled people to get a free COVID-19 test when the criteria for testing were satisfied as judged by doctors and provided free treatment for all confirmed cases, irrespective of their nationality.

The fact that the medical infrastructure has not been overwhelmed in South Korea except for in the Daegu region during February-March 2020 significantly contributed to a relative success of the COVID-19 response.

Interestingly, a study by Younhee Kim and Minah Kang (2014) that compared the efficiency of health care systems by geographical region suggested that Asian countries performed more efficiently than other regions and concluded that countries with inefficient health care systems should treat health care best practices within their regional peer groups as benchmarks. I think this analysis is insightful and can be used for improving the public health response capacity at the national and regional level.

Governance

Two overseeing authorities have operated since day 1. The Central Disaster and Safety Countermeasure headquarters is headed by the prime minister (or the minister of health and welfare depending on the disaster level), while the Korea Disease Control Agency, which prior to September 2020 was the Korea Centers for Disease Control whose organizational structure was strengthened to enable it to better prepare for, conduct research about, and respond to infectious diseases, is led by a director. The Central Disaster and Safety Countermeasure headquarters coordinates the support of all ministries for the Korea Disease Control Agency headquarters by holding daily meetings, including on weekends. Expert committees have been organized and are regularly convened in which key players can get advice on various issues and make decisions based on expert opinions. The operation of these two headquarters in man-

aging COVID-19 is to a degree a realization of Dalgon Lee (2015)'s proposal of a central overseeing agency that has the higher-level administrative decision-making power required to mobilize additional organizations and resources to support on-site capabilities.

Public-Private Partnership

A close partnership between the public and private sectors has been an essential part of Korea's COVID-19 response. On January 27, 2020, the Korea Centers for Disease Control, the Ministry of Food and Drug Safety, and Korean pharmaceutical companies met to facilitate the emergency- use licensing and production of COVID-19 testing kits. The Korea Centers for Disease Control gave the companies of the full genomic sequences of the virus shared by China on January 12. The supply of new real-time PCR-based testing kits began in early February, after the Ministry of Food and Drug Safety granted emergency-use licensing.

The early expansion of testing labs was also a notable feature of South Korea's response. The number of labs increased from 18 on January 31 to 46 by February 7, to 77 by February 25, and to 114 by March 9, and each lab had the capacity to test 20,000 samples per day. Initially, it was public health laboratories that offered COVID-19 testing, but to make testing widely available, hospital laboratories and private testing laboratories began participating in the network as of February 7. The private sector makes possible a high testing capacity, and as of November 2020, the number of tests that can be administered per day is 70,000-80,000.

Innovative drive-through and walk-through sampling methods proposed by doctors greatly enhanced the speed and efficiency of testing. The total number of tests administered had reached 2,873,443, with around 1% confirmed positive cases, as of November 20, 2020.

As public hospitals make up only 5.6% of hospitals in South Korea, private hospitals have had to actively participate in the COVID-19 response. After the outbreak among a religious group in Daegu in February, many doctors, nurses and health care workers from other parts of the country voluntarily flocked to the city to aid in the response efforts.

Community treatment centers for treating mild cases were proposed by doctors and established by the government to prevent hospitals form being overwhelmed and to ensure that hospital beds were reserved for treating severe and critical cases.

Risk Communication and Public Trust

The Central Disaster and Safety Countermeasure headquarters and the Korea Disease Control Agency have given daily briefings since January 20. Details regarding the situation and government policies in response to the crisis have been shared with the public and media to ensure people's right to information. Transparency in communication during the crisis has enhanced public trust in the government, which explains why the public has accepted such government policies as phased social distancing with alacrity.

On April 15, the National Assembly election was held, and the turn-out rate among voter was high at 66.2%. Strict hygienic and social distancing measures were taken throughout the country during the earlier absentee voting and on election day itself. COVID-19 patients and self-quarantined people were allowed to vote separately, after official voting ended. No cases related to the national election were detected. This success attracted a lot of attention from foreign countries.

Phased Social Distancing

Phased social distancing was first introduced on February 29 and continually adjusted by the government in consultation with an expert committee. Starting on May 6, the government introduced a phased reopening of businesses based on risk assessment criteria such as new cases per day, the proportion of cases with unknown sources, the clustering of cases, and cases with known epidemiological links(table 1).

Table 1. Phased Social Distancing in South Korea

	Phase 1	**Phase 2**	**Phase 3**
	small clusters, sporadic	sustained community transmission	big clusters, widespread community transmission
New Cases per Day	<50	50 – 100	100 - >200
Unknown Source	<5%	-	rapid increase
Clustering of Cases	decrease	sustained increase	rapid increase
Known Epidemiological Link	>80%	-	-

On May 27, "daily life distancing," a less stringent form of social distancing, was announced, with updated guidelines from the government on business and daily life activities in such places as schools, public transport, hospitals/clinics, religious facilities, hotels, restaurants, shops, libraries, family events such as weddings and funerals, movie theaters, museums, sports games, and nightlife venues.

Table 2. New Social Distancing Rules Effective from 7 November 2020

	Level 1	Level 1.5	Level 2	Level 2.5	Level 3
	No Outbreak	**Local/Regional Outbreak**		**National Outbreak**	
Outbreak Status	no signs of local or regional outbreaks	early signs of regional outbreak	sustained regional outbreak and early signs of national outbreak	established national outbreak	sustained national outbreak
Capacity	health care capacities not at capacity	beyond regional health care capacities for more than 1 week	increasing trend of overrunning regional capacity	more than 1 week of national health care facilities being beyond capacity	rapid increase of cases threatening health care capacities at the national level
Criteria	<100 new cases in the capital region, <10-30 new cases in other regions (average per week)	>100 new cases in the capital region, >10-30 new cases in other regions (average per week), average age of confirmed cases of >60 years and >40 in capital region, >4-10 in other regions	2 times more new cases than the 1.5 level sustained after 1 week at the 1.5 level, or sustained outbreak for over 1 week after the 1.5 level has been reached in more than 2 regions, or >300 new cases sustained for more than 1 week	>400-500 confirmed cases per week or doubling of cases at level 2, increased proportion of confirmed cases of >60 years, hospital ICU at capacity	>800-1000 confirmed cases per week or doubling of cases at level 2.5, increased proportion of confirmed cases of >60 years, hospital ICU at capacity

In April, Eskild Peterson and his colleagues published a paper on an exit strategy for lockdowns based on a review of the results of interventions in different countries. They suggested that are three essential challenges: the risk of reintroduction of the virus from travelers entering a country from other countries with ongoing community transmission, the need for extensive testing capacity and wide-

spread community testing, and the need for an adequate supply of personal protective equipment (PPE) to protect health care workers. Peterson and his coauthors propose a series of principles for exiting shutdown, including easing "restrictions when the case count has decreased after the peak, has been stable for two weeks, and the hospitals can cope with the number of severe cases," expanding "testing for new and past infections by setting up strategic testing sites" and introducing "testing stations in the community providing diagnostic tests to everyone with compatible symptoms and serological testing for surveillance of population immunity," testing "employees with nucleic acid tests and/or antibody tests before returning to work to find silent cases and recovered persons," imposing "the use of surgical or non-medical face masks whenever outside the household to reduce the risk that those persons with an unrecognized infection will contribute to transmission," imposing "quarantine on arriving passengers from countries with active outbreaks," and maintaining "strong infection prevention measures in all health care institutions" (2020, 239). These principles ought to prove helpful to countries in planning a way out of the shutdown, but, of course, each country will need to decide on its own strategy based on country-specific situations. Starting on November 7, 2020, 5 phases of social distancing in Korea with new criteria and strengthened measures for 23 high risk facilities were communicated.

The Legal System and Privacy Issues

After the MERS outbreak in 2015, a legal framework for collecting and sharing information on confirmed and suspected positive cases was established to ensure the public's right to information. The government amended the National Infectious Disease Prevention and Control Act to give Korea Centers for Disease Control the authority to collect certain types of personal data needed in the context of epidemiological investigation and with the aim of preventing the spread of infectious diseases. Very strong public demand during the MERS outbreak necessitated this amendment.

South Korea's practice of tracking infected persons may raise the eyebrows of people who take privacy seriously. The so-called COVID-19 Smart Management System operates on the basis of cooperation between the National Police Agency, the Credit Finance Association, and the three mobile carriers and 22 credit card issuers in Korea. In this system, information is anonymized and disclosed to the public with extreme care to protect personal information so that those who may have crossed paths with confirmed cases can be tested. While no name of the tracked person is publicized, a fact that is often overlooked in accounts of how the

tracking works, the current system does pose the danger of making it possible for overcurious people to stigmatize confirmed cases. To address the concerns that the information released to the public is too specific, the Korea Centers for Disease Control distributed guidelines to local governments specifying the amount of time the information would be available (a maximum of 14 day) and the scope of the publicly accessible information. In an article from late April, Sangchul Park and colleagues (2020) described the details of contact tracing and proposed more balanced approach for the use of data for epidemiological investigation. They suggested that less granular data pertaining to infected individuals be released to the general public and that transparency was needed in the process. The Korean government subsequently implemented a deidentification method that enables effective tracing while minimizing the encroachment on privacy. The government also is removing expired contact movement information from social media, private websites, and apps.

THE CURRENT SITUATION AND KEY ISSUES: GLOBAL PERSPECTIVES

As of July 27, 2020, 214 countries were reporting COVID-19 cases, one half of which were in North and South America. While the highest number of newly confirmed daily cases were in the United States, Brazil, and India, countries that had managed the outbreak relatively well, such as Australia and Hong Kong, began reporting a sudden increase of new cases. All countries faced the same problem, however, in that in the absence of a vaccine, nonmedical countermeasures such as social distancing, travel restrictions, and disinfection were the only options.

Lockdown

After the historic lockdown of Wuhan declared by the Chinese government on January 23, 2020, many other countries likewise imposed a lockdown in an effort to limit the spread of the virus. The following maps show the response stringency index of countries that imposed stay-at-home requirements, restricted the number of people that could be present at public gatherings, and that closed schools at national or subnational levels. The Korean government recommended that people voluntarily stay at home as a part of social distancing instead of issuing drastic measures such as lockdown.

In May 2020, the Korean government developed detailed guidelines for in-per-

son classes for preschool, primary, middle and special schools. Many countries have canceled in-person classes or introduced hybrid classes. Over the course of the outbreak, countries have adjusted border control countries and social distancing protocols, taking into account economic and societal impacts. In November 2020, South Korea also revised the stages of outbreak, the criteria that characterize these stages, and public health measures for social distancing to better manage outbreaks and balance the health and economic/societal impacts of the virus.

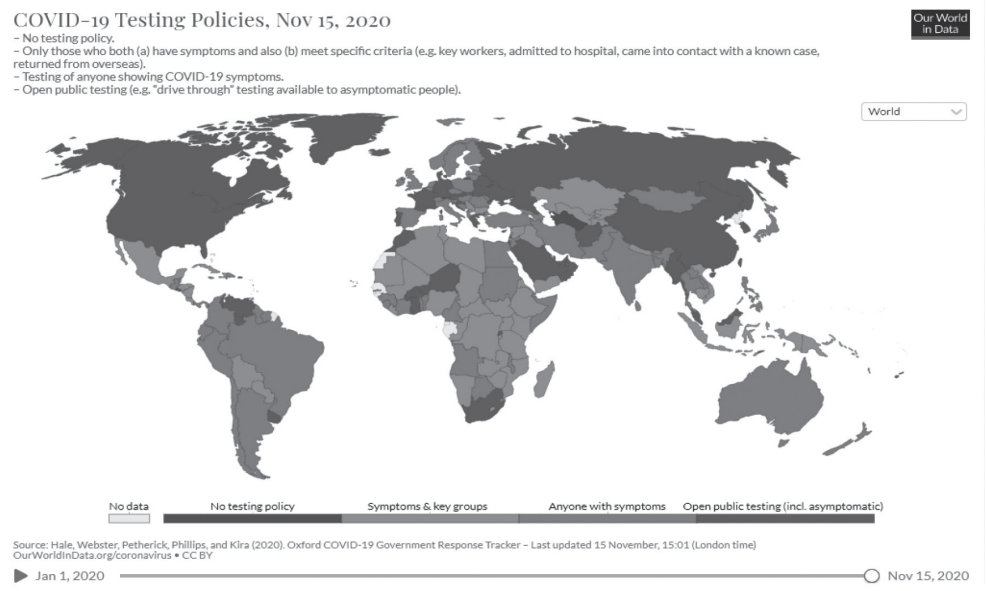
Travel Ban versus Open Borders with Entry Screening

While some countries such as New Zealand, Taiwan, Vietnam, Mongolia and Pacific Island countries adopted strict border closure measures or banned travelers from high-risk countries from entering their countries in the early stages of the outbreak, South Korea's border has remained relatively open, and the government has put a special entry procedure into effect in March 2020, under which all incoming travelers must be tested and undergo a 14-day quarantine after arrival. As the global outbreak situation is continuously changing, the border control policy has been adjusted based on regular risk assessment. As of July 13, South Korea strengthened the requirements for foreign workers arriving from high-risk countries by asking that they submit negative results of PCR test performed within 48 hours of their departure from their home country. However, exemptions from the 14- day quarantine requirement may be granted for bushiness, press, and academic activities and for funerals. In addition, a fast-track entry procedure has been arranged for business travel between Korea and China, Indonesia, Singapore, and Japan as of November 2020. Under this arrangement, travelers are expected to submit a 14-day monitoring log and negative results of testing performed within 72 hours of departure from their home country.

Testing Policy and Positive Rates

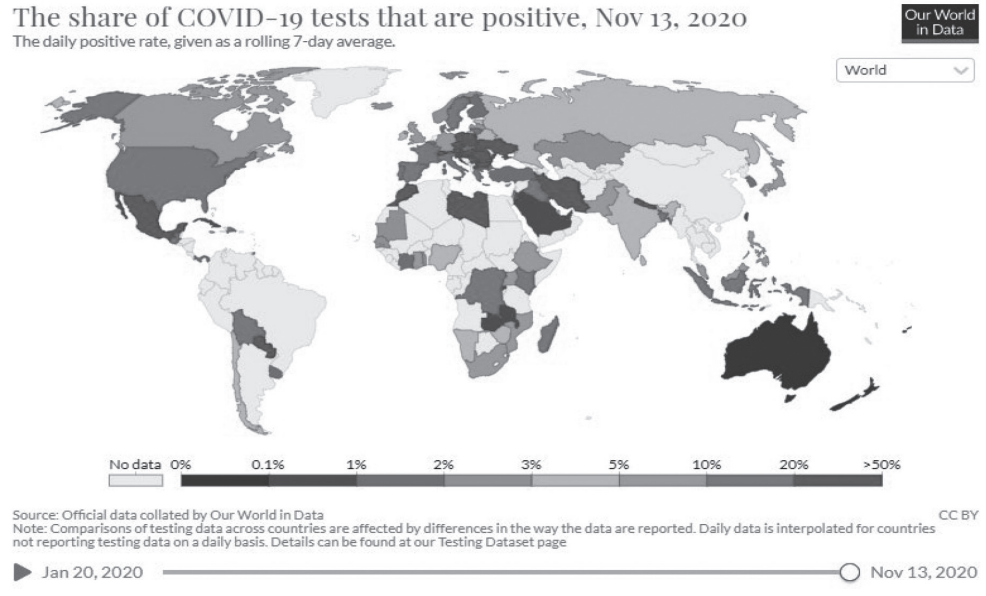
Testing policy for COVID-19 varies around the globe (figure 5). While some countries including South Korea test even asymptomatic people, others test only people with symptoms or symptoms among essential workers and groups suspected of having been exposed to the virus. It is obvious that extensive testing makes it easier to trace, isolate cases, and quarantine contacts. With the changing situation, many countries have also changed their testing policies.

Figure 5. Comparison of COVID-19 Testing Policies in Effect as of November 15, 2020



Source: OurWorldindata.org

Figure 6. Comparison of the Share of Positive COVID-19 Tests as of November 13



Source: OurWorldindata.org

It is probable that countries with very high positive rates do not tests enough to find all cases. The WHO has suggested a positive rate of around 3-12% as a general benchmark of adequate testing and proposed a rate of less than 5% as an indicator that the outbreak is well controlled. As of July 18, South Korea, Australia, and Canada had positive rates of less than 1% while Mexico and Bolivia recorded positive rates of greater than 50% (figure 6).

INTERIM EVALUATION OF COVID-19 RESPONSES IN SOUTH KOREA

The South Korean government has handled the situation in a democratic and transparent manner without lockdown and with minimum travel restriction measures. This has been possible thanks to the immediate response of the Korean Centers for Disease Control after China reported the outbreak of an unknown pneumonia in Wuhan on December 31, 2019, to the WHO. Prompt responses, emergency-use authorization of PCR testing kits in early February, the establishment of community treatment centers, the introduction of a smart tracking system for contact tracing, public private partnerships, improvements to the medical infrastructure, and lessons learned from MERS outbreak in 2015 were named by Exemplars in Global Health as major factors for the success of the COVID-19 response in South Korea

Timeline of Korea's Early Response

On January 3, three days after China first reported the outbreak of the disease to WHO, the emergency operation center of the Korean Centers for Disease Control implemented enhanced entry screening for travelers from Wuhan. Two days later, the Korean Centers for Disease Control alerted clinicians to look out for patients with respiratory symptoms and a history of travel to Wuhan. This information-gathering effort was supported by the drug utilization review system, which provided the travel histories of patients at health facilities. The Korean Centers for Disease Control simultaneously issued guidance to clinicians at national designated isolation hospitals and, a few days later, to local governments. On January 20, a person who had returned from Wuhan turned out to be the first laboratory confirmed case. The government scaled up the alert level (a four-level national crisis management system from blue (level one) to yellow (level two). The alert level was raised to three on January 27 and to four on February 23.

Emergency-Use Authorization of COVID-19 Testing Kits

One of most significant steps in Korea's response was the emergency-use licensing and production of COVID-19 testing kits that was agreed to on January 27 at a meeting of the Korean Centers for Disease Control, the Ministry of Food and Drug Safety, and pharmaceutical companies. Several pharmaceutical companies began the production of testing kits under the condition of emergency-use authorization and those kits were distributed to

Establishment of Community Treatment Centers

To prevent an overwhelming number of patients in hospitals and to ensure optimal treatment of severe and critical cases as well as of non-COVID 19 patients by hospitals, the government established community treatment centers for mild cases in collaboration with the private sector. This arrangement proved to be successful in meeting the challenges of the situation in Daegu in February.

Use of Information and Communication Technology and a Smart Tracking System

For the tracing of movement of cases and contacts, information and communication technology methods were extensively used pursuant to the legal framework of the National Infectious Disease Prevention and Control Act revised after the MERS outbreak in 2015. The Ministry of Land, Infrastructure, and Transport, the Ministry of Science and Information and Communication Technology, and the Korean Centers for Disease Control developed a smart tracking system to which data have been supplied by mobile phone carriers, the National Police Agency, and 22 credit card companies. The system has shortened the time required for epidemiological investigation from about 24 hours to 10 minutes.

Lessons Learned from MERS-CoV Outbreak in 2015

Above all, South Korea's experience of the MERS outbreak in 2015 gave painful but precious lessons that drove the country to improve its capacity to respond to public health emergencies. The Korean Centers for Disease Control established an emergency operation center and a dedicated risk communication team and laboratory analysis center and introduced an emergency- use licensing system in collaboration with the Ministry of Food and Drug Safety, which turned out to be the most significant

institutional tool in the prompt response to the COVID-19 virus. In addition, as already noted, the government revised the National Infectious Disease Control and Prevention Act to enable the Korean Centers for Disease Control to collect certain types of personal data needed for epidemiological investigation. The strengthening of the infrastructure was also among the post-MERS improvements. The improvements (increase in the number of negative pressure rooms at hospitals, the reinforcement of field response teams, and the enhancement of interministerial and private-public collaboration) were internationally recognized in the WHO IHR (2005) Joint External Evaluation in 2017.

Revision of WHO International Health Regulations (IHR)

The WHO emergency committee for COVID-19 was established in January 2020, and five online meetings were organized in 2020. The committee meets to advise the WHO director general as to whether the current level of COVID-19 outbreak constitutes a public health emergency of international concern and to provide temporary recommendations to the WHO and its member states. Ina recent article titled "WHO International Health Regulations Emergency Committee for the COVID-19 Outbreak" (2020), I have outlined the process of how the WHO decides whether a given epidemic constitutes a public health emergency of international concern as well as described the WHO's major recommendations. I emphasize the importance of WHO's role in the response to COVID-19 and of global cooperation in COVID-19 research and development in our efforts to overcome this crisis. While the WHO has made various attempts to coordinate at an international level the necessary support to rescind the public health emergency of international concern status as soon as possible, the current IHR does not confer the authority on WHO to take any action against member states that do not implement its recommendations. Only one of the four components of the IHR monitoring and evaluation framework—namely, the state party self-assessment report—is mandatory, while IHR joint external evaluation, simulation exercises, and after-action review are performed on a voluntary basis (see table 4). My belief is that it is necessary to revise the IHR to make the four components of monitoring and evaluation framework mandatory and to secure the human and financial resources the WHO country offices as well as the headquarters and the six regional offices need to ensure compliance.

Table 3. The Four Components of IHR Monitoring and Evaluation Framework

	IHR MONITORING AND EVALUATION FRAMEWORK			
	States Parties self-assessment annual reporting (SPAR)	**After action reviews (AAR)**	**Simulation exercices (SimEx)**	**Voluntary External Evaluations**
Purpose	Monitor progress towards implementation of IHR core capacities	Assess the functionality of capacities during real events	Assess the potential functionality of capacities for non-real events	Evaluates objectively IHR contribute to health security
Mandate	Mandatory	Voluntary	Voluntary	Voluntary
Focus	Existence of capacities	Functionality of capacities	Functionality of capacities	Existence of capacities
Periodicity	Annually	Within 3 months of specific real events	Regularly when required as part of the exercise programme	Every 4-5 years
Type	Quantitative	Qualitative	Qualitative	Quantitative

Source: International Health Regulation (IHR) Monitoring and Evaluation Framework (2018)

Global Collaboration for Research and Development: International Solidarity Trials

The global scientific community is demonstrating an unprecedented fervor in pressing ahead with COVID-19 research and development (R&D), primarily for vaccines and treatments. Since January 10, 2020, the WHO R&D blueprint team has been coordinating global R&D by overseeing nine working groups conducting research in close collaboration with GLOPID-r and other global health research partners. On February 11-12, 2020, the WHO organized the first Global Research and Innovation Forum and produced the first global COVID-19 research roadmap.

The second and third forums were held by way of a virtual meeting on July 1-2, 2020, during which the research progress made since the first forum was shared. Particularly notable was the presentation of the interim results of the international solidarity trials for treatments and vaccines. Also discussed were target product profiles regarding the efficacy, safety, the duration of protection and of COVID-19 vaccines and the target population for these vaccines. In June 2020, the Korea Ministry of Food and Drug Safety and US Federal Drug Administration had announced their

ideas regarding COVID-19 vaccine development based on WHO COVID-19 target product profiles. International solidarity trials are expected to greatly facilitate the development of treatments and vaccines for COVID-19.

So far, South Korea's participation in international solidarity trials in therapeutics and vaccines has been minimal partly because of the relatively low number of cases in the county and also due to the lack of a coordination mechanism at the national level. The following two maps show where COVID-19 clinical studies exploring therapeutic treatments and vaccines are being carried out as of November 11, 2020. In South Korea, 22 trials for therapeutic treatments and 2 trials for vaccine are under way.

Figure 7. Living Mapping and Living Systematic Review of COVID-19 Clinical Studies for Therapeutics as of November 11, 2020

Source: WHO Covid-19 data, https://www.covid-nma.com/dataviz

Figure 8. Living Mapping and Living Systematic Review of COVID-19 Clinical Studies for Vaccines as of November 11, 2020

Source: Covid-19 Living NMA Initiative from WHO, https://covid-nma.com/vaccines/mapping

POLICY PROPOSALS

Infrastructure and Human Resources for Public Health

Infrastructural improvements such as the securing of a substantial number of negative pressure rooms, personal protective equipment, and ventilators, were made after the 2015 MERS outbreak. However, further reinforcement of medical facilities and equipment is required to prepare for any further waves of COVID-19 and other new infectious diseases in the future. Above all, a personnel strategy is needed so that a larger number of public health and infectious disease experts and trained health care workers are able to assist in responding to crises. The government also needs to strengthen human resources and improve the quality of existing public hospitals.

Public-Private Partnerships

As we have witnessed during the COVID-19 experience, public-private partnerships are essential in responding to health crises. While it is important to increase the number of public hospitals and improve the quality of those hospitals, the government also needs to establish a strategy for further collaboration with private hospitals in emergency preparedness and response to infectious diseases.

R&D

In the last few months, progress in COVID-19 R&D in South Korea has been relatively slow, compared to the country's efforts in containing the spread of the virus. Accumulated data on epidemiology, clinical manifestations, and public health measures as well as basic research need to be promptly published and shared with the global community. During the last 5 years, the R&D budget for infectious disease research and infrastructure in Korea has been dramatically increased but it still needs to be further expanded. To satisfy research needs in a timely manner, emergency R&D funds, which can be mobilized as quickly as within a month, should be increased.

The establishment of the National Institute of Infectious Disease Research under the Korean Centers for Disease Control and the Virus Research Institute under the Ministry of Science and Information and Communications Technology was recently approved by the National Assembly. The functions of the organizations need to be coordinated with each other to maximize their capacity to support COVID-19-related R&D including the development of vaccines and therapeutic treatments. Ideally, the National Institute of Infectious Disease Research should be an independent institute from the Korean Centers for Disease Control, following the US model of the Centers for Disease Control and the National Institute of Allergy and Infectious Diseases. By the end of 2020, a National Vaccine Research Center will be established within the National Institute of Infectious Disease Research. This center should play a significant role in improving national vaccine self-sufficiency and taking the Korean vaccine industry to a global level. Partnerships and collaborations with vaccine manufacturers, research institutes, universities and other ministries, including the Ministry of Food and Drug Safety, will be critical to achieving the goal of national vaccine self-sufficiency and globalization of the vaccine industry.

Global and Regional Collaboration and National Coordination

The establishment of an Asia-Pacific center for disease control and prevention has been also contemplated as an organization to complement WHO's emergency preparedness and response function. Different countries' experiences in combatting COVID-19 could be utilized to strengthen regional and national public health capacities in the Asia-Pacific region. One of the most important roles of such an organization would be the collection and analysis of regional data through a platform agreed on by the participating countries. Such a center could collaborate with the WHO Western Pacific Regional Office and the South-East Asia Regional Office to implement such strategies as the Asia-Pacific Strategy for Emerging Diseases and Public Health Emergencies 2017 and to implement IHR rules.

The government needs to scale up the R&D budget for infectious diseases not only for national projects but also for global health initiatives such as WHO's R&D program and the Coalition for Epidemic Preparedness and Innovation as well as the Research Investment for Global Health Technology Fund. The interministerial coordination mechanism for infectious disease R&D should also be strengthened to make it possible for collaboration among ministries to produce tangible outcomes.

Conclusion and Next Steps

Korea's response to COVID-19 has been praised as open, transparent, and democratic. No travel restrictions have been implemented except against travelers from Hubei. In this respect, Korea has been compliant with the WHO COVID-19 emergency committee's advice on travel restrictions, which is that there is no zero risk and so countries have to assess the risk of easing restrictions based on their specific circumstances. Instead of instituting a travel ban, Korea introduced a special entry procedure including COVID-19 testing and a 14-day self-quarantine period on February 4 for travelers from China, which was expanded to travelers from all countries on March 19.

One of the lessons Korea learned from the MERS experience was that lack of risk communication was a determining factor in the failure of its response to the outbreak. In the current crisis, political interference in risk communication has been minimized, and this has contributed to enhancing public trust in government action.

While South Korea's response has been praised for its speed and efficiency, the country has not made sufficient efforts to share epidemiological and clinical findings and results of public health response measures with the international community.

Some people think Korea's success is due to a strong central government tradition, but the truth is that Korea decentralized testing by empowering local public health institutes from the outset and designated hospitals and private testing laborato-

ries as early as February 7. Unique public-private and central-local cooperation frameworks have been decisive in enabling extensive testing, comprehensive tracing, and effective treatment.

I propose that the following steps should be taken to evaluate Korea's outbreak response from January to July 2020, which in turn will better prepare the country to manage the next stage of the COVID-19 pandemic and future pandemics.

1) Produce an interim evaluation report of the emergency response that takes into account public-private partnerships, governance, the legal system, infrastructure, research and development, and international collaboration.
2) Closely collaborate with national and international experts who have participated in the COVID-19 response and build a collective knowledge platform to be shared internationally.
3) Develop a comprehensive national action plan to further strengthen public health preparedness and response based on lessons learned from the COVID-19 outbreak and an interministerial monitoring platform to assess the annual progress of the national action plan once the pandemic has been brought under control.

We are in an era of "planetary co-immunism," one that awakens the world to the urgent need to cooperate globally and mobilize collective knowledge in responding to a ferocious revolt of nature (Gardels, 2020).

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REFERENCES

Chang, J. 2017. Public health disasters and the evolution of pandemic response structures: A case study of MERS in Korea. *Korean Journal of Policy Studies*, 32(1): 27-52.

Gardels, N. 2020. Planetary co-immunism is on the way: This global pandemic is the great accelerator. Berggruen Institute, March 20. Retrieved on December 14, 2020, from https://www.berggruen.org/the-worldpost/articles/weekend-roundup-planetary-co-immunism-is-on-the-way.

Jee, Y. 2020. WHO International Health Regulations Emergency Committee for the COVID-19 outbreak. *Epidemiology and Health*, 42: e2020013.

Kim, Y., & Kang, M. 2014. The measurement of health care system efficiency: Cross-country comparison by geographical region. *Korean Journal of Policy Studies*, 29(1): 21-44.

Lee, D. 2015. Government administrative control tower in crisis management system: Definition, issues, and policy implications. *Korean Journal of Policy Studies*, 30(3): 125-145.

Park, S., Choi, G. J., & Ko, H. 2020. Information technology-based tracing strategy in response to COVID-19 in South Korea: Privacy controversies. *Journal of American Medical Association*, 323(21): 2129-2130.

Peterson, E., Wasserman, S., Lee, S., Go, U., Holmes, A. H., Seif, A.-A,⋯ & Tambyahk, P. 2020. COVID-19—We urgently need to start developing an exit strategy. *International Journal of Infectious Diseases*, 96: 233-239.