Strategical Preparedness and Response Actions in the Healthcare System Against Coronavirus Disease 2019 according to Transmission Scenario in Korea

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ABSTRACT

The dynamic nature of coronavirus disease 2019 (COVID-19) pandemic requires us to be efficient and flexible in resource utilization. The strategical preparedness and response actions of the healthcare system are the key component to contain COVID-19 and to decrease its case fatality ratio. Depending on the epidemiological situation, each medical institution should systematically share the responsibility for patient screening, disposition and treatment according to clinical severity. To overcome fast-paced COVID-19 pandemic, the government should be rapidly ready and primed for action according to the specific transmission scenario.

Keywords: Health care facilities, manpower and services; Emergency preparedness; COVID-19

Korea has been lauded for the successful response for first wave of the outbreak of coronavirus disease 2019 (COVID-19) [1]. Active patient diagnosis by expanding testing capabilities and exhaustive tracing of people in contact with COVID-19 patients, have contributed to contain the disease transmissions in the community [2]. However, in Daegu, Korea, the geographic mass clustering of outbreaks overwhelmed a local health care system [3]. In the light of experience, a single unsupportive person or group can ignite another massive outbreak and push the health care system into the groggy state.

Active ongoing surveillance to find the closet patients in the community will help the proactive recognition of the upcoming wave [4]. Also, out of ad hoc response, the beds available for the
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enormous surge of COVID-19 patient should be prepared in advance. During the reorganization to scale-up the capacity of the public medical system in the public health crisis, personnel and resources must be mobilized among public and private health institutions. Even, primary care clinics as well as academic and teaching hospitals, should share the burden for aggressive testing, mitigation of transmission, and minimal associated mortality.

Therefore, we suggest preparedness and response actions in the healthcare system against COVID-19 according to the transmission scenario in Korea on our experiences.

HEALTHCARE SYSTEM IN KOREA AND TRANSMISSION SCENARIO

The healthcare system of Korea is under a national health insurance system achieving universal coverage for all Korean citizens. The medical institutions are classified by the function, the number of beds and specialty departments as follows: public health centers, private clinic (<30 beds), hospital (30 – 99 beds), general hospital (≥100 beds, 6 – 9 specialities) and tertiary care hospital (≥500 beds, ≥20 specialities) [5].

The public sector only accounts for approximately 5% of the total healthcare facilities [5]. Therefore, it is inevitable for all medical institutions including the private hospitals to switch public functions in the public health crisis.

Based on interim guidance published in World Health Organization [6], we defined the transmission scenario of the public health crisis caused by infectious disease as shown in Table 1.

Table 1. The summary of strategical preparedness and response actions in healthcare system against COVID-19 according to transmission scenario in Korea

| Resources utilization | Scenario 1 | Scenario 2 | Scenario 3 | Scenario 4 |
|-----------------------|------------|------------|------------|------------|
| Maintenance           | Maintenance| Activation & enhancement | Scale-up | Maximally scale-up |
| Subjects for case detection | Imported case- and contact of confirmed case-oriented | Imported case- and contact of confirmed case-oriented | Imported case-, cluster occurrence-, contact of confirmed case- and symptom based-oriented | Imported case-, cluster occurrence-, contact of confirmed case- and symptom based oriented |
| Surveillance          | SARI, KINRESS | SARI, KINRESS, Kukmin Ansim hospital-based enhancement | SARI, KINRESS, Kukmin Ansim hospital-based enhancement, ARIC-based enhancement including cases of ARI in hospitals or long-term care facilities | SARI, KINRESS, Kukmin Ansim hospital-based enhancement and expansion, ARIC-based enhancement and expansion |
| Active screening      | Enhanced quarantine inspections, ARIC, COVID-19 screening center, Kukmin Ansim hospital | Enhanced quarantine inspections, ARIC, public massive screening clinics, Kukmin Ansim hospital, and mass screening-based enhancement | ARIC, public massive screening clinics, Kukmin Ansim hospital, and mass screening-based enhancement and expansion |
| Case management       | Government-designated hospitals | Government-designated hospitals Non-designated private academic and teaching hospitals Public hospitals Temporary care facilities | Government-designated hospitals Non-designated private academic and teaching hospitals Public hospitals Temporary care facilities Private hospitals |

Based on interim guidance on critical preparedness, readiness, and response actions published in World Health Organization, we defined the transmission scenario as follows; Scenario 1. No cases; Scenario 2. 1 or more cases, imported or locally detected; Scenario 3. Cluster outbreak in time, geographic locations and/or common exposure; Scenario 4. Larger outbreaks of local transmission. "Kukmin Ansim hospital" system should include screening for COVID-19 and preemptive isolation of patients with pneumonia. Government-designated hospitals have beds that should be mobilized in the situation of crisis such as COVID-19. Temporary care facilities are the building such as hotels, conventional hall, and gymnasium that are converted for isolation and monitoring of COVID-19 patients. COVID-19, coronavirus disease 2019; SARI, severe acute respiratory infection surveillance; KINRESS, Korea Influenza and Respiratory Surveillance System; ARIC, acute respiratory infection clinics; ARI, acute respiratory infection.
ACTIVE CASE DETECTION AT EACH FACILITY LEVEL

To suppress expansion of the outbreak, enhanced case ascertainment and multipronged surveillance strategies in point of care or laboratory settings are indispensable. They were stepwise extended to find each missed case, as shown in Table 1. The roles of each healthcare facility in case detection were summarized in Figure 1, according to the evolving epidemic situation. However, the response actions should be able to be carried out radically beyond the phased scenario stage. These prepared strategies should be activated quickly and flexibly depending on the situation.

Scenario 1: Symptomatic screening or occasionally mandatory 14-day self-quarantine for visitors and residents with stay in the past 14 days to selected countries or regions should be performed. In Korea, there are two kinds of routine surveillance system for acute respiratory tract infection (ARI). One is the Korea Influenza and Respiratory Surveillance System (KINRESS) of community-based surveillance systemmainly involved in private primary

| Scenario | SARS-CoV-2 surveillance | Screening |
|----------|-------------------------|-----------|
| 1        | KINRESS                 | SARI      |
| 2        | KINRESS                 | ARIC      |
| 3        | KINRESS                 | ARIC      |
| 4        | KINRESS                 | ARIC      |

Figure 1. The scheme of strategical preparedness and response action in the healthcare system for the case detection of COVID-19 in Korea. Based on interim guidance on critical preparedness, readiness, and response actions published in World Health Organization, we defined the transmission scenario as follows; Scenario 1: No cases; Scenario 2: 1 or more cases, imported or locally detected; Scenario 3: Cluster outbreak in time, geographic locations and/or common exposure; Scenario 4: Larger outbreaks of local transmission. “Kukmin Ansim hospital” system should include screening for COVID-19 and preemptive isolation of patients with pneumonia.

COVID-19, coronavirus disease 2019; SARS-CoV-2, severe acute respiratory syndrome coronavirus 2; KINRESS, Korea Influenza and Respiratory Surveillance System; SARI, severe acute respiratory infection surveillance; ARIC, acute respiratory infection clinics.
The other is severe acute respiratory infection (SARI) surveillance of hospital-based surveillance system mainly involved in academic and teaching hospitals. The test of severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) is added in these surveillance systems, and the participation of healthcare institutions can be gradually expanded. Constant community-based surveillance targeting small and medium-sized hospitals and long-term care facilities should be gradually expanded.

Scenario 2: Imported cases should be prevented from seeding local transmission, through enhanced quarantine inspection. Although patients suspicious of COVID-19 will mainly visit COVID-19 screening centers, some may visit primary care clinics first. In terms of infection control and prevention, most private clinics have no adequate equipment to care COVID-19 patients. In order for primary care clinics to function in a safe setting, acute respiratory infection clinics (ARIC) should be established. The construct of ARIC equipped with facilities was designed with the flow of human traffic in mind, and medical personnel were recruited as volunteers from primary physicians and government officials, who were well educated in infection control and prevention. The treatment space is divided into a district for patients with ARI and without ARI. Each ARIC should nominate an infection control manager, as a communication channel in an epidemic situation and a actor of surveillance sentinel for specific infectious diseases in the non-epidemic situation.

“Kukmin Ansim hospital” system should be activated in all levels of voluntarily participating healthcare facilities, including public and private institutions. This system includes active surveillance, extensive case screening, and preemptive isolation of all patients with pneumonia under spatially separated out-patient clinics or in-patient negative-pressure or air-borne infection isolation rooms for patients with ARI. From this stage, infection control for all hospitals and long-term care facilities should be strengthened together.

Scenario 3: Clinical discretion in requesting testing were important in detecting patients without epidemiologic linkage in the community, to minimize the risk of developing possible large cluster of COVID-19 cases. In the situation from scenario 3 and 4, ARIC is dedicated to screening for COVID-19 patients, so that other private clinics ordinarily maintain their care.

A similar model has already been implemented as the public health preparedness clinic (PHPC) in Singapore. Similarly, the public massive screening clinic in Gyeonggi-do of Korea has been operated.

Scenario 4: The number of private institutions participating in the ARIC should be maximized. The mass screening system such as “drive-through” and “walk-in” can be established. The public health center will manage this system, based on the additional support-personnel resources along with a separate facility. To be dedicated to case management, the government-designated public hospitals can halt surveillance and screening.

CASE MANAGEMENT

Once sustained community transmission is established, COVID-19 can disrupt the health care system nationally and push the vulnerable to death. The control tower should estimate the shortage of intensive care unit (ICU) beds and non-ICU beds, as well as hospital isolation room capacity. Treatment facilities both for mild and for severe COVID-19 cases should be
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designated and reserved under the nationwide monitoring of treatment situation. Physicians treating COVID-19 cases should be supported to interact actively on clinical networks where new therapeutic modalities and experiences are interchanged.

The roles of each healthcare facility in case management were summarized in Table 1 and Figure 1, according to the evolving epidemic situation. Figure 2 shows the allocation of the patient’s bed according to the clinical severity. Based on severity criteria published by Korea Center for Disease Control and prevention (KCDC) [12], healthcare personnel should triage patients and prepare differential facilities for patients with diverse severity.

Scenario 2: Since 2003 SARS outbreak, the government has selected and supported as government-designated hospitals that can be mobilized in the public health crisis. All COVID-19 patients are admitted to the hospitals, till resolution of symptoms and laboratory evidence of SARS-CoV-2 clearance.

Scenario 3: Above all, public hospitals should be dedicated to treating COVID-19 patients with asymptomatic infection or mild illness. Since 2009 H1N1 influenza pandemic, the government had provided financial support to make negative-pressure or air-borne infection isolation rooms in both public and private healthcare facilities. Those with government-designated beds should participate in caring for COVID-19 patients with moderate to severe or fatal illness. In order to efficiently distribute the bed and manpower, the rapid bed circulation of the severe patients should also be considered. Temporary care facilities can be activated for caring the patients in the recovery phase. With the help of volunteers, buildings such as training center for government officials or companies, hotels, conventional hall, and gymnasium will be converted for isolation and monitoring of the patients. Human resources should be reassigned from private hospitals to operate these public hospitals and temporary care facilities.

Scenario 4: All available resources must be mobilized for reinforcing healthcare systems and reducing transmission. If there happens a big surge, capacity of the government-designated

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**Table 1**

| Scenario  | COVID-19 case detection | Government-designated hospitals | Recovery phase | Ending isolation |
|-----------|-------------------------|---------------------------------|----------------|-----------------|
| Scenario 2: | Asymptomatic/Mild | Government-designated hospitals | Recovery phase | Ending isolation |
| Scenario 3: | Asymptomatic/Mild | Public hospitals | Recovery phase | Ending isolation |
| Scenario 4: | Asymptomatic/Mild | Public hospitals | Recovery phase | Ending isolation |

**Figure 2.** The scheme of strategical preparedness and response action in the healthcare system for the case management of COVID-19 in Korea. Based on interim guidance on critical preparedness, readiness, and response actions published in World Health Organization, we defined the transmission scenario as follows; Scenario 1: No cases; Scenario 2: 1 or more cases, imported or locally detected; Scenario 3: Cluster outbreak in time, geographic locations and/or common exposure; Scenario 4: Larger outbreaks of local transmission. Government-designated hospitals have beds that should be mobilized in the situation of crisis such as COVID-19. Temporary care facilities are the building such as hotels, conventional hall, and gymnasium that are converted for isolation and monitoring of patients with COVID-19.

COVID-19, coronavirus disease 2019.
public hospitals will not be enough to hospitalize all the COVID-19 patients. The risk of rapid clinical deterioration can be addressed by admitting mild patients to temporary care facilities. During their surge beyond capacity of facilities, to minimize severe illness and fatal outcomes, non-designated private academic and teaching hospitals should be equipped and trained to care for COVID-19 cases.

THE RESPONSIBILITY AND AUTHORITY OF THE GOVERNMENT

In Korea, where private clinics and hospitals provide most medical services, voluntary participation of private medical institutions is essential to tough out the long-term pandemic or resurgence of COVID-19. To activate response action according to the transmission scenario, the government should make every administrative effort at the right moment. First, extensive financial support is mandatory to compensate for the damage of each medical institution, installation of facilities, supply of medical equipment, and personnel expenses. Second, the government must develop institutional and legal preconditions to maintain the healthcare system in the public health crisis. Third, the government must provide a training resource for infection control personnel and make a communicating system with them. Finally, the government should extend investment in the public health sector to establish the preparedness and response action system.

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