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Article Summary Line: In an infectious disease pandemic, patients with mild symptoms can be treated in a monitoring isolation facility, such as an LTSC, which assists in the efficient distribution of limited medical resources.

Running Title: A Living Treatment Support Center for COVID19

Title: A Suggestion from South Korea for Treatment of Mild or Asymptomatic COVID-19 Infected Patients: Living and Treatment Support Center

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Abstract

With the outbreak of coronavirus disease 2019 (COVID-19), there is a need for efficient management of patients with mild or no symptoms, which account for the majority. The aim of this study is to introduce the structure and operation protocol of a living and treatment support centre (LTSC) operated by Seoul National University Hospital in South Korea. The existing accommodation facility was converted into a 'patient centre' where patients was isolated. A few Medical staff here performed medical tests and responded to emergencies. Another part of the LTSC was 'remote monitoring centre'. In this center, patients' self-measured vital signs and symptoms were monitored twice a day, and the medical staff staying here provided video-consultation via a smartphone. During the 3 weeks from March 5 to March 26, 2020, 113

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patients were admitted and treated. LTSC could be an efficient alternative to hospital admission in pandemic situation like COVID-19.

Keywords: COVID-19; mild patients; quarantine facility; video-consultation; living and treatment support center

Introduction

Since the first suspected patient was reported in December 2019 (*1*, *2*), the number of patients with coronavirus disease 2019 (COVID-19) has risen steeply worldwide (*3*, *4*). In Korea, patients suspected of having COVID-19 were first identified on January 8, 2020. In February, outbreaks occurred at religious facilities and the number of patients increased drastically, especially in Daegu City and the North Gyeongsang Province. The number of patients with asymptomatic or mild symptoms increased exponentially, as demonstrated by a thorough investigation of contacts, the development of diagnostic kits/protocols (*5*) and new screening systems, such as drive-through screening centres (*6*).

In the early stages of the COVID-19 epidemic, all patients diagnosed with COVID-19 were hospitalized in negative-pressure isolation units to treat the disease and prevent the spread of infection. However, as the infection spreads rapidly, the number of patients exceeded the number of negative-pressure isolation beds (according to the Ministry of Health and Welfare (MoHW), there were 1,027 negative-pressure isolation beds in Korea in 2020). After the negative-pressure isolation unit was full, COVID-19 patients began to be treated in general hospital beds. However, the hospital beds soon became scarce, mainly in the areas where outbreaks occurred. There were growing concerns that new facilities were needed to isolate and care for patients given the limited medical resources and the epidemic curve of COVID-19.

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When there is an imbalance between the demand and supply of medical resources, adequate triage of patients is critical for allocating limited resources to patients who can benefit the most. The inadequate allocation of medical resources can lead to high-risk patients being untreated while awaiting admission, which leads to fatal results for patients (*7*). In a large-scale Chinese study, 80% of COVID-19 patients were reported to have no symptoms or mild symptoms, and only 20% of infected patients needed medical services (*8*). In Korea, among the 9,137 cumulative cases until March 25, 126 died and 3,730 were cured; the mortality rate in Korea was 1.4% (*9*). Compared with the known mortality rate of COVID-19, which is 2.3% (*8*), the proportion of mild-condition patients who do not require hospitalization is estimated to be higher in Korea. However, considering COVID-19's asymptomatic carrier transmission(*10*) and high reproductive number (2.2) (*11*) and the possibility of sudden deterioration (*12*), isolation and patient monitoring were necessary for mild or asymptomatic patients. Accordingly, on March 2, 2020, when the number of confirmed COVID-19 patients awaiting admission to the hospital reached approximately 2,000, the government started the operation of a community treatment centre called the "living and treatment support centre" (LTSC), which is able to provide quarantine, regular examination, and monitoring of COVID-19 patients. The essential elements of an LTSC are as follows: 1) patient isolation, 2) regular patient monitoring, 3) regular patient examination, and 4) response to patient emergencies. As of March 25, there were 17 LTSCs nationwide serving patients with mild symptoms.

The LTSC is a new type of quarantine facility that can monitor and isolate mild-condition patients in emerging infectious disease disaster situations. The purpose of this study is to introduce the structure and operation protocol of the LTSC, which was implemented in Korea in 2020 during the COVID-19 pandemic.

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Methods

Study setting

The National Health Insurance System (NHIS) of Korea offers complete access to healthcare for the entire Korean population—regardless of a person's ability to pay—through the National Health Insurance (NHI) and medical aid programme (*13*). Due to the weak gatekeeper function of primary care physicians, healthcare accessibility is very high in Korea. Despite having the fewest physicians among OECD countries (2.3 per 1,000 population) and a shortage of nurses (6.9 per 1,000 population), Korea's medical utilization rate is the highest among OECD countries, with 16.6 outpatient visits per capita, and the number of hospital beds is 2.6 times higher than the average number of OECD countries (12.3 per 1,000 population) (*14*). Therefore, Koreans had high accessibility of medical services prior to the disaster and were accustomed to visiting hospitals even if their condition was mild. However, although the total number of hospital beds is sufficient, there are only 1,027 negative-pressure isolation beds, and there is regional variation in distribution. When the COVID-19 pandemic occurred, the number of available negative-pressure isolation beds decreased, especially in regions where outbreaks mainly occurred.

Intervention - Living and treatment support centres (LTSCs)

Seoul National University Hospital (SNUH) is a teaching hospital with 1,700 beds. The Mungyeong Human Resource Development (HRD) Center is a facility that is normally used for training SNUH staff. It is not a medical facility; it is an accommodation facility with beds and bathrooms. It has seven floors and a total of 100 rooms, including 82 rooms for two people, 16 rooms for four people, and 2 rooms for disabled people on the basement level. As the COVID-19

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outbreak continues, SNUH decided to repurpose the facility by converting it into a kind of medical facility to isolate and care for infected patients. After preparations for the transition of the accommodation facility to a medical facility and the establishment of the monitoring centre in SNUH, on March 5, 2020, it began operating as the third LTSC in Korea.

Study population

Screening criteria for patients for LTSC

The Korea Centres for Disease Control and Prevention (KCDC) classified the severity of COVID-19 into four stages, namely, very severe, severe, mild, and asymptomatic(*15*). Mild is defined as alert and meeting one or more of the following conditions: <50 years old, one or more underlying diseases, and <38℃ with antipyretic drugs. Asymptomatic is defined as alert, <50 years old, no underlying disease, non-smoker, and <37.5℃ without antipyretic drugs. Mild and asymptomatic are defined as mild conditions.

Considering the above stage criteria, subjects who are candidates for LTSC meet one of the following criteria among mild condition patients: 1) among hospitalized patients, cases that do not necessarily require hospitalization, 2) cases that require only monitoring, 3) cases that are unable to properly self-isolate (no suitable place to live, living with a high-risk group, etc.), and 4) cases determined necessary by the local government to enter LTSC. Despite the above criteria, patients judged by medical staff to be in need of hospitalization and high-risk groups were hospitalized. Examples of high-risk groups are people with chronic disease (haematologic malignancy, malignancy with chemotherapy, and immunocompromised patients), SpO2<90% with room air, obesity, pregnancy, patients on dialysis, and transplant patients.

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The community public health centre checked for these criteria for patients who were awaiting hospitalization at home and sent the patient directly to the LTSC if the criteria were met. For hospitalized patients, their physicians checked the criteria and sent eligible patients to the LTSC along with a previous chest radiography image.

Criteria for discharge of patients from the LTSC

As determined by the KCDC, two criteria exist for the release of quarantine in Korea. Symptomatic patients are discharged if symptoms disappear and their RT-PCR test is negative twice (24 hours apart), and asymptomatic patients are discharged if their RT-PCR test is negative twice after the 7th day after diagnosis.

Results

Overall operating structure

The LTSC consists of two centres: the patient centre and the monitoring centre. Patients were admitted to the Mungyeong HRD centre (the patient centre), and a monitoring centre installed in SNUH provided video-consultation services by doctors and nurses (Figure 1). In the patient centre, personnel from the MoHW, local government, hospitals, military, police, and fire agency stayed and provided various services necessary for the operation of the LTSC. Table 1 shows the role and service of each institution (Table 1).

Patient centre in Mungyeong HRD centre

To use the accommodation facility as a patient isolation facility, the building was divided into a dirty area and a clean area. The space where medical staff and operating staff work is designated as a clean area, and the patient's living area is designated as a dirty area. A separate

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entrance for each section was designated, and a separate space was prepared for the grey zone, such as removing personal protective gear.

To use the electronic medical record (EMR) system in the patient centre, a hospital network was installed in addition to the usual internet service. Equipment for the RT-PCR test (tools and a refrigerator) and a portable X-ray bus for chest X-ray were placed next to the building. According to the national guidelines for COVID-19, doctors collected RT-PCR samples regularly (on a 2-day cycle for negative cases and a 3- or 7-day cycle for positive cases) and sent the samples to SNUH to be tested.

Chest X-rays were checked every 3 days or daily for patients with abnormal findings on chest imaging until normalization to detect pneumonia. The X-ray image was read by a radiologist in SNUH through the picture archiving and communication system (PACS) of SNUH. RT-PCR results and X-ray results could be checked in both the patient centre and the monitoring centre through the EMR system. Essential medicines such as antipyretic drugs and cough medicines were stored in the centre and provided by a doctor's prescription.

More than two medical staff (doctor or nurse) always stayed in the patient centre to respond to emergencies. Two doctors and two nurses worked during the daytime, and one doctor and two nurses were on duty at night. One doctor acted as the medical director, and one nurse acted as an infection manager. All staff, including medical staff, were checked for fever and respiratory symptoms (cough, sputum, stuffy nose, sore throat, chest discomfort and dyspnoea) twice a day. When any abnormalities were reported, the medical director checked the staff member and provided the COVID-19 test if necessary.

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Each room of the patient centre was equipped with an automatic blood pressure monitor, digital thermometer, and pulse oximeter so that patients in the room could check vital signs independently. Meals were provided three times a day, and laundry was done by the patient in the room. Visits by guardians or other visitors were prohibited.

Monitoring centre in SNUH - The video-consultation care model

The video-consultation care model for COVID-19 patients utilizes an interprofessional, integrative clinical team to provide patient-centred care. Video-consultation care services include patients' self-measurement of vital signs, monitoring by nurses and doctors for vital signs and patient symptoms, video consultation with nurses and doctors, in-depth psychological consultation by a psychiatrist if necessary, and consultation with infectious disease specialists and radiologists. A monitoring centre was established at SNUH, where medical resources are concentrated. This monitoring centre was equipped with computers and monitors, smartphone devices, webcams, headsets for video consultation, and two large dashboard monitors to briefly check the patients' vital signs and symptoms.

The patients admitted to the LTSC checked vital signs twice a day, namely, blood pressure, body temperature, pulse, respiratory rate, and oxygen saturation (at 9 am and 4.30 pm). Patients reported their symptoms, including respiratory symptoms, twice a day through a questionnaire sent by the smartphone application, and the nurse monitored the responses and vital signs. The nurse provided video consultations twice a day, at 9 am–12 pm and 5 pm–8 pm. If the nurse decided that video consultation with a doctor was necessary, the doctor provided additional video consultation. The doctor regularly monitored patients' vital signs and symptoms once a day and conducted regular video consultations once every two days. Both nurses and

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doctors provided video consultations for an average of five minutes or more per patient and monitored patients' symptoms and vital signs for more than three minutes per patient (Table 2).

Isolated patients underwent a comprehensive psychiatric assessment once per week to evaluate their depressive mood, anxiety, suicidal risk, and post-traumatic stress. The questionnaire included the Patient Health Questionnaire (PHQ-9), Generalized Anxiety Disorder Scale (GAD-7), P4 Suicidality Screener, Posttraumatic Stress Disorder (PTSD) checklist for DSM-5 criteria (PCL-5), and Patient Health Questionnaire (PHQ-15). In high-risk groups, psychiatrists conducted a separate in-depth psychological consultation using the same video-consultation system. The results of patients' chest X-rays were all read by radiologists at SNUH. When a chest X-ray had abnormal findings or the patient's symptoms worsened, the doctor of the monitoring centre consulted with an infectious disease specialist at SNUH.

Preparation for emergencies

LTSC established an emergency referral system with nearby medical institutions to respond to any emergencies or disease aggravation. In the event of an emergency, medical staff on duty in the patient centre visited the room with protective gear. The patient centre was equipped with an emergency cart normally used in the hospital, a portable oxygen tank to cope with emergencies, and a stretcher car with a negative-pressure air tent for transfer.

After evaluation by the field medical staff, patients in need of hospitalization were transferred to a COVID-19 designated hospital that had a negative-pressure isolation unit. The criteria for transport to a hospital was an abnormality in the vital signs measured every day or pneumonia in the chest X-ray. Patients were transferred by ambulance from the nearest ambulance station. If an emergency situation occurred, such as abrupt respiratory failure, the

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patient was first transferred to the nearest emergency room for treatment and, after stabilization, transferred to a hospitalized bed. The overall flow of LTSC patient care is shown in Figure 2.

Characteristics of patients in the LTSC

In total, 113 patients were admitted to the LTSC during the 3 weeks of the COVID-19 outbreak from March 5 to March 26. Of these, 59 were female (52.2%), and 54 were male (47.8%). The patients' average age was 30.4 years (the youngest was nine, and the oldest was 65 years old). The average number of days of illness at the time of admission was 5.1 days. The most frequent symptoms were cough (N = 31, 27.4%), followed by sputum (22.1%), rhinorrhoea (15.9%), and chest discomfort (7.1%). A total of 3.5% of patients had a fever within three days (N = 4), and only one patient had a fever at the time of admission. In total, 86.7% of patients had no fever since being diagnosed with COVID-19. A total of 16.8% of patients had a previously diagnosed disease (N = 19), of which the most common was rhinitis (N = 5), followed by hypertension (N = 4). In total, 10.6% had abnormalities in chest X-rays performed on the day of admission, of which more than half were non-specific haziness or opacity; only one showed pneumonia (Table 3).

Discussion

LTSC was established for isolation and monitoring of mild-condition patients of COVID-19 during a pandemic when the demand for medical resources exceeds supply. The existing accommodation facility was converted to a medical facility, and video-consultation care using a smartphone was provided to minimize contact with infectious patients. The hospital operated the LTSC and provided medical services. Public officers from the MoHW, local government, military, police, and fire agency supported the operation, including food delivery and patient

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transfer. During the 3-week operation, 113 mild-condition patients were admitted to LTSC and cared for.

As COVID-19 spreads worldwide, the shortage of medical resources has become a serious problem in many countries (*16, 17*). The lack of medical resources such as hospital beds, intensive care units (ICUs), and ventilators can lead to failure to treat patients adequately (*18, 19*). Furthermore, during the crisis of the pandemic, a shortage of quarantine facilities, usually hospitals, leads to failure to control the transmission of infectious diseases (*20*). When the demand for medical resources is greater than the supply, proper patient triage and resource allocation are crucial factors for disaster response. In a pandemic situation, hospitals do not have sufficient medical equipment, such as ventilators and extracorporeal membrane oxygenation (ECMO), for all patients. To maximize benefit and save patients, a hospital that has sufficient medical equipment and can provide maximum medical services should be used for critically ill patients. However, even for mild conditions, it is essential to observe the progress of disease carefully because of uncertainty in the clinical course of emerging infectious disease. Proper isolation of cases is also necessary to prevent further spread of disease (*20*).

Korea has many acute care beds and high medical accessibility with the NHIS (*21*). Although 80% of COVID-19 patients had mild conditions, in the early stage of the epidemic, all COVID-19 patients were admitted to the negative-pressure isolation room according to the principle of first-come, first served (*8*). As the pandemic progressed rapidly, however, hospital beds became scarce (*22*), and more than 2,000 patients were awaiting admission at home. This group included high-risk patients, such as elderly patients with comorbidities (*23*). Meanwhile, at least two patients died at home while waiting for admission, and the need for medical facilities and the redistribution of medical resources increased (*22,24*). Some patients hospitalized in the

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early stages of the endemic did not require active treatment but needed isolation and monitoring. However, due to the possibility of sudden deterioration and difficulties in the control of self-isolation at home (*20*), it was difficult to discharge an infected patient who was already hospitalized. Accordingly, there is a need for a new quarantine model to ensure beds in a fully equipped hospital to monitor and isolate mild-condition patients. In this situation, the LTSC, an intermediate model between self-isolation at home and hospital isolation, was introduced. The LTSC can be an alternative to this dilemma between hospitals with sufficient medical facilities and homes with no facilities.

The core aim of LTSC is to isolate patients in single rooms with bathrooms and provide care with video consultation. Since this LTSC model can be applied to various types of accommodations, such as resorts and hotels, as a kind of surge capacity, it can be a method to quickly secure a quarantine bed in a pandemic crisis. Additionally, allowing patients to independently measure their vital signs and monitoring patients via video calls have several advantages. First, this approach minimizes the risk of infection of health care workers (HCWs) through patient contact. In the pandemic, the infection or quarantine of HCWs is a serious problem because it exacerbates the problem of scarce medical resources (*16*). Second, since video conferences are possible regardless of distance, they allow regions with sufficient resources to support regions with insufficient resources. In our model, Mungyeong, where the patient centre is located, and Seoul, where the monitoring centre is located, are 153 km from each other. The LTSC used a video-consultation model instead of a conventional telephone interview model because it could provide additional visual signs or diagnostic clues (*25*,*26*). Advanced telecommunication technology via smartphones and self-measurement equipment made this model possible.

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During the first 3 weeks (March 5 to March 26), the LTSC of SNUH admitted a total of 113 patients. Of these patients, 103 patients were admitted directly from home and 10 were transferred from the hospital during the recovery period. During the 3 weeks, 49 patients recovered and were discharged, and 2 patients were transferred to a COVID-19 designated hospital for hospitalization. With regard to discharge, the average length of stay was 15.7 days (interquartile range (IQR) 5-21 days), and the average interval from diagnosis to discharge was 19.5 days (IQR 10-27 days). With regard to transfer, one patient was transferred after persistent pneumonia on the chest X-ray for 3 days, and another patient was transferred for close monitoring due to newly developed dyspnoea and O2 demand for 1 L/min. In both patients, after detecting the deterioration in video consultation, the medical staff staying in the patient centre evaluated the patients in their rooms and decided to transfer. Both patients were safely admitted to the hospital.

After the first LTSC opened on March 2, a total of 3,292 patients were admitted to 17 LTSCs until March 26. This covered 35.6% of the 9,241 cumulative confirmed COVID-19 cases in Korea. There was no death or respiratory failure while 17 LTSCs operated for 24 days. The LTSC is a model for safe monitoring and isolation of mild-condition COVID-19 patients in the pandemic. When there is a shortage of medical resources, it is crucial to triage patients properly and allocate resources accordingly. It is important to both provide the highest level of care to critically ill patients and provide efficient and safe treatment to mild-condition patients. The LTSC model could be a useful reference in disaster situations where the demand for medical care overwhelms the supply, such as the current global pandemic of COVID-19.

In conclusion, to safely isolate and monitor the mild condition of COVID-19 patients in the pandemic, a model of community treatment centres (living and treatment support centres,

LTSCs) was developed as an intermediate model between the hospital and self-isolation at home. By classification according to the severity of patient symptoms and underlying disease, mild-condition patients can be treated at LTSCs safely.

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Biographical Sketch

Dr. Lee is a clinical assistant professor of Public Healthcare Center, Seoul National University Hospital. Her research interests are emergency medical system and health policies. Dr. Kang is a clinical assistant professor of Public Healthcare Center and Department of Family Medicine, Seoul National University Hospital. Her research interests are chronic disease management, palliative care, self-management of patients and health policies.

Footnotes

[1]These first authors contributed equally to this article.

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Table 1. Role and service of related organizations of living and treatment support centres

Organization	Role and service
The Ministry of Health and Welfare	Contact point for Central Disaster and Safety Countermeasure Headquarters, provision and application of guidelines for LTSC
Local government	Support for goods such as protective gear, administrative support such as meal/disinfection/waste disposal
Hospital (SNUH)	General operation of the LTSC, medical services including patient monitoring, assessment and medication prescription
Facility (HRD centre)	Facility management
Military	Food delivery, patient movement control
Police	Outsider access control, patrol around facility
Fire agency	Contact point for emergency service for transfer, patient movement control

LTSC, living and treatment support centres; SNUH, Seoul National University Hospital; HRD, human resources and development

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Table 2. Video-consultation care model in the monitoring centre

	Doctor	Nurse
Interval of video consultation	Once every two days	Twice a day
Interval of monitoring patients' symptoms and vital signs	Once a day	Twice a day
Average time per video consultation	5 min	5 min
Average number of patients per medical staff	30 patients	18 patients
Model's total workforce (per 113 patients)	3 or 4 doctors	12 nurses

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Table 3. Characteristics of patients in the living and treatment support centre (N=113)

Characteristics		N	%
Sex	Male	54	47.8
	Female	59	52.2
Age, years old (mean ± SD)		30.4 ± 12.9	
Average number of days of illness*, days (mean ± SD)		5.1 ± 3.5	
Fever	At the time of the admission	1	0.9
	Within three days	4	3.5
	Within 2 weeks	15	13.3
	Never	98	86.7
Symptoms on admission	Cough	31	27.4
	Sputum	25	22.1
	Rhinorrhoea	18	15.9
	Chest discomfort	8	7.1
	Sore throat	7	6.2
	Dyspnoea	5	4.4
Previously diagnosed disease	Rhinitis	5	4.4
	Hypertension	4	3.5
	Diabetes	1	0.9
	Asthma	1	0.9
	Chronic bronchitis	1	0.9
	Other disease†	8	7.1
	None	94	83.2
Vital signs	Systolic blood pressure, mmHg	113.6	11.8

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(mean + SD)	Diastolic blood pressure, mmHg	75.9	9.2
	Respiratory rate, times/min	16.6	5.4
	Heart rate, times/min	82.6	11.5
	Body temperature, °C	36.3	0.6
	Oxygen saturation, %	96.1	4.5
Chest X-ray	Abnormal findings	12	10.6
	Within normal limits	101	89.4

LTSC, living and treatment support centres; SD, standard deviation

*At the time of admission

†Anaemia, hyperthyroidism, hyperlipidaemia, tachycardia, cerebral aneurysm, chronic hepatitis, reflux oesophagitis and gout were included

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Figure 1. Overall operating structure of the living and treatment support center

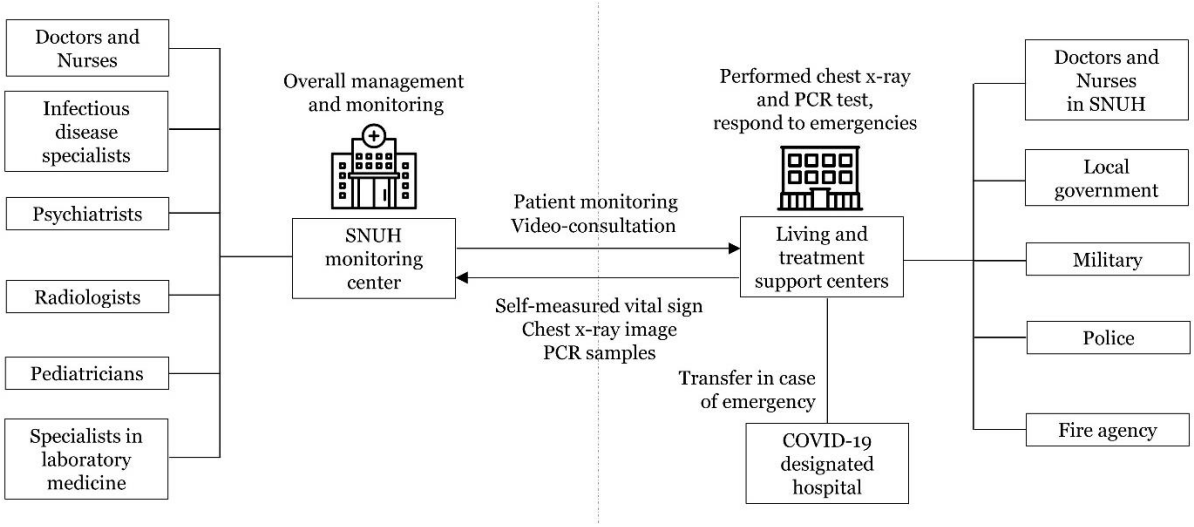

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Figure 2. Protocol for management of COVID-19 patients in the living and treatment support center