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The protocol and clinical characteristics of patients under "at-home care" for coronavirus disease 2019 in South Korea: a retrospective cohort study

Journal:	<i>BMJ Open</i>
Manuscript ID	bmjopen-2022-061765
Article Type:	Original research
Date Submitted by the Author:	04-Feb-2022
Complete List of Authors:	Park, Jin Ju; Hallym University College of Medicine, Department of Internal Medicine Seo, Yu Bin; Hallym University College of Medicine, Department of Internal Medicine Lee, J; Hallym University College of Medicine, Department of Internal medicine Na, Sun Hee; Hallym University College of Medicine, Department of Internal Medicine Choi, Young Kyun; Chungnam National University College of Medicine, Department of Internal Medicine
Keywords:	COVID-19, Public health < INFECTIOUS DISEASES, INFECTIOUS DISEASES

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Title**The protocol and clinical characteristics of patients under “at-home care” for coronavirus disease 2019 in South Korea: a retrospective cohort study**

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Word count: 3415

Abstract

Objective

As the number of patients with coronavirus disease 2019 (COVID-19) increased, at-home care was introduced for the first time in South Korea. This study aimed to analyze the characteristics and outcomes of patients who were treated under at-home care.

Design, setting, and participants

This retrospective cohort study targeted patients under at-home care for COVID-19 in Yeongdeungpo-gu in Seoul, Korea, from October 18, 2021, to December 12, 2021.

Results

During the study period, a total of 1,422 patients were enrolled in this study, and 9,579 patient days were managed. Those over 60 years accounted for the most (22.7% [n=323]), and 82.8% did not have underlying conditions. The median length of care for patients was 8 days (interquartile range: 5-10). During the study period, a total of 986 (69.3%) patients were released from quarantine, 82 (5.8%) patients were transferred to facilities, and 354 (24.9%) patients were under at-home care. The common cause of transfer was sustained fever (n = 30, 36.6%), followed by dyspnea and desaturation (n = 17, 20.7%). Factors associated with transfer were diabetes (odds ratio [OR]: 3.591, 95% confidence interval [CI]: 1.488-8.665, $P = 0.004$), pregnancy (OR: 5.839, 95% CI: 1.035-32.935, $P = 0.046$), and being pre-symptomatic at diagnosis (OR: 4.015, 95% CI: 1.559-10.337, $P = 0.004$).

Conclusions

There were no specific problems related to patient safety when operating at-home care. For safe at-home care, patients with risk factors such as diabetes or those with newly presented

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4 symptoms need more careful monitoring, and it is necessary to prepare for an appropriate
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6 response to the emergency.
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10 **Keywords:** COVID-19; home care; protocol; outcome

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12 **Strengths and limitations of this study:**

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15 • The study emphasizes the need to prepare for an appropriate response to an
16 emergency during at-home care.
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20 • This was a single-center retrospective cohort study.
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24 • This study depicted the early phase of at-home care for patients with COVID-
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INTRODUCTION

Severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) was first discovered in Wuhan, China in December 2019, and since the World Health Organization announced the pandemic in March 2020, there have been approximately 290 million confirmed cases of coronavirus disease 2019 (COVID-19) worldwide, as of December 2021.[1,2] With the development of vaccines, the number of confirmed cases in the United States and Europe seemed to be decreasing, but due to the easing of the quarantine measures and the presentation of new variants, the number of confirmed cases was skyrocketing again. There was no difference in the domestic situation. With the start of vaccination, the overall quarantine level was relieved. However, subsequently, the fourth epidemic occurred in Korea. In addition, emerging new variants have led to the updating of new confirmed cases every day.[3]

During each epidemic situation, the medical system faced a crisis, and it was accompanied by difficulties in allocating medical personnel, supplies, and beds. During the initial epidemic, community treatment centers (CTC) for asymptomatic or mild patients were operated to fill the medical gap in Korea.[4–6] As the epidemic progressed, it became difficult to cope with the increasing number of patients with COVID-19 by CTC alone. The occurrence of pediatric and psychological problems was another challenge for the CTC setting.[7,8]

As the COVID-19 pandemic protracted, the Korean government modified its policy for management of critically ill patients with COVID-19. The domestic metropolitan area introduced at-home care as an alternative to a deficient medical system. This is the first home healthcare system for the management and monitoring of patients suffering from infectious diseases in Korea. To overcome the current COVID-19 pandemic and prepare for a new novel infectious disease, a well-established at-home care system is required. In this study, we aimed

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4 to introduce the protocol of at-home care that is being implemented in our institution and
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6 analyze the characteristics and outcomes of patients under at-home care during the COVID-19
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8 pandemic.
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MATERIALS AND METHODS

Study design, setting and study population

This was a retrospective cohort study that used medical records. Kangnam Sacred Heart Hospital is a secondary medical institution with 572 beds located in Yeongdeungpo-gu, Seoul, South Korea. Our institution signed an agreement with Yeongdeungpo-gu administration as an at-home care medical institution on October 5, 2021, and started operating on October 18, 2021. All patients who were under at-home care in Kangnam Sacred Heart Hospital between October 18, 2021, and December 12, 2021, were included in this study.

Criteria for enrollment and release from quarantine

Enrollment criteria

In Korea, policies for the care of patients with COVID-19 were changed, and the criteria for at-home care were also changed on November 26, 2021.

Before November 26, 2021, the Korea Centers for Disease Control and Prevention classified patients with asymptomatic and mild symptoms under 70 years of age without hospitalization factors (mental change after symptom onset of COVID-19, dyspnea, uncontrolled fever with antipyretics, uncontrolled diabetes mellitus (DM), hemodialysis, patients treated for chronic lung disease, asthma, heart failure, coronary artery disease, patients under chemotherapy or immunosuppressant, uncontrolled symptomatic psychiatric disease, bedridden states, obese [body mass index > 30], pregnant with symptoms such as abdominal pain, labor, vaginal bleeding, severe childhood or with a high risk of dyspnea, cyanosis, chest depression, poor oral intake, or dehydration, diagnosed with chronic lung disease/cardiac disease/metabolic

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4 disease/abnormal immune system, under immunosuppressant, respiratory function or excretion
5 problem, or risk of aspiration) as candidates for at-home care, with consent. In patients over 60
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8 years, only those who had been vaccinated, were registered for at-home care. Patients in need
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11 of care, such as minors and those with disabilities, were required to be accompanied by a
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13 protector.[9] The exclusion criteria were as follows: 1) those who lived in a residential
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15 environment vulnerable to infection due to difficulty in blocking contact with others; 2) when
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17 communication for non-face-to-face health care and quarantine management was difficult for
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19 the patient or protector.
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24 From November 26, patients confirmed of having COVID-19 were all allocated to at-home
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26 care, except in the following cases: 1) those who had hospitalization factor (mental change
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28 after symptom onset of COVID-19, dyspnea, uncontrolled fever with antipyretics longer than
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30 3 days, uncontrolled DM, hemodialysis, patients treated for chronic lung disease, asthma, heart
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32 failure, coronary artery disease, patients under chemotherapy or immunosuppressant,
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34 uncontrolled symptomatic psychiatric disease, bedridden states, pregnant with symptoms such
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36 as abdominal pain, labor, vaginal bleeding, severe childhood or with high risk of dyspnea,
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38 cyanosis, chest depression, poor oral intake, or dehydration, diagnosed with chronic lung
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40 disease/cardiac disease/metabolic disease/abnormal immune system, under
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42 immunosuppressant, respiratory function or excretion problem, or risk of aspiration), 2) those
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44 who lived in a residential environment vulnerable to infection, 3) minor, disabled or over 70
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46 years who required care but could not be quarantined together with a protector, 4) those who
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48 were deemed too difficult to treat with at-home care by the head of the local government.[10]
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57 Criteria for release from quarantine
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4 Symptomatic patients were released from quarantine 10 days after the symptom onset.[9]
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6 Asymptomatic patients were released from quarantine 10 days after the diagnosis. The
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8 quarantine date was extended, depending on the occurrence of symptoms, and the final decision
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10 for release was made by the medical staff.
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17 **Intervention**

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20 Kangnam Sacred Heart Hospital operated at-home care by targeting patients with COVID-19
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22 residing in Yeongdeungpo-gu. The at-home care program involved four medical doctors and
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24 five nurses in one monitoring room. They operated during the day and used an on-call system
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26 at night. One doctor was in-charge per day, but a backup doctor was designated in case of an
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28 emergency. Nurses worked in two shifts, with two nurses during the daytime and evening and
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30 one during the night for the on-call system.
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34 Yeondeungpo-gu public health center classified patients with COVID-19 for at-home care
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36 according to the enrollment criteria and supplied items necessary for at-home care such as
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38 antipyretics, oxygen saturation monitor, thermometer, and phone numbers of related medical
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40 institutions. The patients to be managed were registered as outpatients with assigned doctors
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42 every day so that prescriptions were available if needed. The list of patients under at-home care
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44 was secured through the public health center and updated daily.
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49 The monitoring room was equipped with computers, monitors, and smartphone devices.
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51 Patients checked their blood pressure and body temperature and uploaded the data in their
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53 smartphone applications. Nurses called the patient at 9 a.m. and 5 p.m. every day to check the
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55 patient's vital signs and symptoms and update patient information on electronic health records.
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4 If the patient had symptoms and wanted to take medication, the doctor interviewed the patient
5 and prescribed the medicine. The prescription was sent to the public health center by fax. After
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9 prescribing the medicine at the pharmacy, the person in charge of the public health center
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11 delivered the medicine to the patient's house. If the patient had persistent fever, desaturation,
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13 or worsening of clinical symptoms, the doctor interviewed the patient and decided whether to
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15 transfer the patient to other facilities, such as CTC or hospitals, according to the severity. The
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17 public health center assigned an ambulance and medical institution and transported.
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21 The medical staff checked the list of patients who were subject to release from quarantine and
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23 whether it was possible to release from quarantine according to the criteria, every day. The
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25 results were reported to the public health center.
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31 **Data collection and Statistical analysis**

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34 Data regarding patient characteristics such as age, sex, enrollment date, release from quarantine
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36 date, transfer date (if transferred), symptoms, and medical prescription were collected through
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38 a retrospective medical record review.
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42 Continuous variables were presented as mean \pm standard deviation (SD) or median
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44 (interquartile range [IQR]), as appropriate. Statistical significance was assessed using the chi-
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46 square test and Fisher's exact test for categorical variables. Non-categorical variables were
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48 tested using the two-sided unpaired t-test or Mann-Whitney U test. The factors associated with
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50 transfer were calculated using a logistic regression model. Statistical significance was set at P
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52 < 0.05 . Statistical analyses were performed using IBM SPSS ver. 27 (IBM SPSS Inc., Armonk,
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54 NY, USA).
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Patient and public involvement

None (not applicable to this type of study).

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RESULTS

Baseline characteristics of study population

During the study period, 1,453 patients were registered. Three patients moved to another district, and 28 patients were excluded from at-home care on the day of admission due to other causes of admission, such as severe symptoms at diagnosis. A total of 1,422 patients and 9,574 patient days were managed under at-home care at Kangnam Sacred Heart Hospital. The number of patients managed daily is shown in Figure 1.

Among 1,422 patients, 725 (51.0%) were men, and the median age was 40 (IQR: 27-58, range: 0-87) years (Table 1). Those over 60 years accounted for the most (22.7% [n = 323]), followed by those in their 30's (18.5% [n = 263]). Most of them (n = 1,177; 82.8%) did not have underlying conditions, and hypertension (n = 153; 10.8%) was the most common comorbidity. Approximately 16.4% (n = 233) of patients under at-home care were asymptomatic. There were 209 cases of drug prescriptions in 176 (12.4%) patients. On average, 3.7 (SD: 3.73, range: 0-16 per day) prescriptions were requested per day. Symptoms for the prescribed drugs are described in Table 2. The most common symptom was cough (n = 115; 55.8%), followed by sputum (n = 62; 30.1%), and sore throat (n = 54; 26.2%). The number of night call was 68 cases (range: 0-6 cases per day) which was an average of 1.2 (SD: 1.64) night call per day.

Table 1. Baseline characteristics of patients under at-home care system (n = 1422)

Characteristics	Total (N = 1422)	Released from quarantine (N = 986)	Transferred (N = 82)	P-value
	No (%)	No (%)	No (%)	
		No (%)		

Sex					0.873
Male	725 (51.0)	508 (51.5)	43 (52.4)		
Female	697 (49.0)	478 (48.5)	39 (47.6)		
Age, years, mean	40 (0-87)	40 (0-83)	45 (1-87)		0.051
(range)					
0-9	156 (11.0)	109 (11.1)	3 (3.7)		
10-19	122 (8.6)	73 (7.4)	10 (12.2)		
20-29	151 (10.6)	112 (11.4)	8 (9.8)		
30-39	263 (18.5)	194 (19.7)	14 (17.1)		
40-49	186 (13.1)	120 (12.2)	11 (13.4)		
50-59	221(15.5)	152 (15.4)	11 (13.4)		
≥ 60	323 (22.7)	225 (22.9)	25 (30.5)		
Underlying conditions					
hypertension	153 (10.8)	99 (10.0)	15 (18.3)		0.020
diabetes	43 (3.0)	28 (2.8)	7 (8.5)		0.005
thyroid disease	22 (1.5)	17 (1.7)	0 (0)		0.231
psychiatric disorder	12 (0.8)	10 (1.0)	1 (1.2)		0.860
pregnancy	6 (0.4)	4 (0.4)	2 (2.4)		0.018
others*	53 (3.7)	26 (2.6)	5 (6.1)		
none	1177 (82.8)	820 (83.2)	60 (73.2)		0.022
Symptoms					0.009
Asymptomatic	233 (16.4)	159 (16.1)	7 (8.5)		
Pre-symptomatic	160 (11.3)	89 (9.0)	15 (18.3)		

Symptomatic	1029 (72.4)	738 (74.8)	60 (73.2)	
Medicine prescription	176 (12.4)	117 (11.9)	21 (25.6)	0.020
Transfer to healthcare facilities	82 (5.8)			
Hospitals			51 (62.2)	
Community treatment center			31 (37.8)	
Median days from symptoms to diagnosis, days (IQR)	2 (1-4)	2 (1-4)	2 (1-3.75)	0.307
Median days from diagnosis to management, days (IQR)	1 (0-1)	1 (0-2)	0 (0-1)	< 0.001
Median management days ***, days (IQR)	8 (5-10)	8 (6-10)	3 (2-4.25)	< 0.001

IQR: Interquartile range

* epilepsy, autoimmune disease, liver disease, asthma, bronchiectasis, angina, cerebrovascular disease, ulcerative colitis

** conjunctivitis, urticaria, nausea, diarrhea

*** release from quarantine and transferred patients, excluded under management

Table 2. Symptoms for prescription medication (n = 209)

Symptoms*	No. (%)
Cough	115 (55.8)
Sputum	62 (30.1)
Sore throat	54 (26.2)
Nasal congestion	38 (18.4)
Rhinorrhea	33 (16.0)
Fever	17 (8.3)
Headache	14 (6.8)
Myalgia	8 (3.9)
Conjunctivitis	7 (3.4)
Gastrointestinal symptoms	7 (3.4)
Other**	10 (4.9)

* allow duplicates

** sleep disorder, febrile sense, underlying disease

The median length from symptoms to diagnosis was 2 (IQR: 1-4) days, and from diagnosis to management was 1 (IQR: 0-1) day. The median length of care for patients was 8 days (IQR: 5-10). During the study period, a total of 986 (69.3%) patients were released from quarantine, 82 (5.8%) patients were transferred to CTC or hospitals, and 354 (24.9%) patients were under at-home care.

Characteristics according to transfer

A total of 83 (5.8%) patients were transferred. Fifty-one (62.2%) patients were transferred to

the hospital and others were transferred to CTC (n = 31; 37.8%). Sex and age did not differ significantly according to the transfer (Table 1). Among the transferred patients, 52.4% (n = 43) were male, and patients over 60 years (n = 25; 30.5%) were mostly transferred. Patients with comorbidities were significantly more likely to be transferred than those who were released from quarantine (25.8% vs. 16.8%, $P = 0.022$). The proportion of patients with hypertension and DM was significantly higher in transferred patients (10.0% vs. 18.3%, $P = 0.020$, 2.8% vs. 8.5%, $P = 0.005$). The proportion of pregnant women was significantly higher in the transferred patients (0.4% vs. 2.4%, $P = 0.018$). The median management duration of at-home care was 8 (IQR: 6-10) days for release from quarantine and 3 (IQR: 2-4.25) days for transferred patients.

The common cause of transfer was sustained fever (n = 30; 36.6%) (Table 3). Seventeen patients (20.7%) were transferred because of dyspnea, and their oxygen saturation was less than 90%. Median 5 (IQR: 4-8) days were taken from symptom onset to transfer request and, median 3 (IQR: 2-5) days were required from diagnosis to transfer request. Most transfers (n = 61; 75.5%) were made on the same day as the transfer requests. For 21 (25.6%) patients, it took 1 day for the allocation of a bed after request. One patient required 2 days and one patient required 3 days for transfer. All patients with dyspnea were transferred on the same day.

Table 3. Reasons for transfer (n = 82)

Reasons	No. (%)
Sustained fever	30 (36.6)
Dyspnea/desaturation	17 (20.7)
Patients wanted	13 (15.9)

Cough/chest pain	9 (11.0)
Resident with family	5 (6.10)
Minor	4 (4.9)
Aggravation of underlying disease	2 (2.4)
As protector	1 (1.2)
Old age	1 (1.2)

Risk factors for transfer

The factors associated with transfer are shown in Table 4. In univariate analysis, age and sex were not significantly associated with transfer. The presence of underlying disease (odds ratio [OR]: 1.811, 95% confidence interval [CI]: 1.081-3.035, $P = 0.024$), hypertension (OR: 2.006, 95% CI: 1.104-3.644, $P = 0.022$), DM (OR: 3.193, 95% CI: 1.350-7.553, $P = 0.008$), and pregnancy (OR: 6.137, 95% CI: 1.107-34.023, $P = 0.038$) were significantly associated with transfer. On multivariate analysis, we found no significant association of age and sex with transfer. DM (OR: 3.591, 95% CI: 1.488-8.665, $P = 0.004$), pregnancy (OR: 5.839, 95% CI: 1.035-32.935, $P = 0.046$), and being pre-symptomatic (OR: 4.015, 95% CI: 1.559-10.337, $P = 0.004$) were independent risk factors for transfer.

Table 4. Factors associated with transfer

Variables	Univariate analysis			Multivariate analysis		
	OR	95% CI	P -value	OR	95% CI	P -value
Sex, female	0.964	0.614-	0.873	0.742	0.579-	0.742
		1.513			1.476	

Age						
0-9	0.385	0.100-	0.167	0.439	0.112-	0.238
10-19	1.918	1.491	0.191	2.169	1.723	0.126
20-29	reference	0.723-	reference	reference	0.804-	reference
30-39	0.982	5.086	0.982	0.957	5.849	0.924
40-49	0.605		0.605	1.371		0.521
50-59	0.978	0.411-	0.978	0.961	0.384-	0.937
> 60	0.300	2.483	0.300	1.346	2.386	0.518
		0.498-			0.523-	
		3.306			3.596	
		0.395-			0.360-	
		2.601			2.566	
		0.677-			0.547-	
		3.544			3.315	
Underlying	1.811	1.081-	0.024	0.662	0.219-	0.465
disease		3.035			1.999	
Hypertension	2.006	1.104-	0.022	2.106	0.682-	0.196
		3.644			10.208	
Diabetes	3.193	1.350-	0.008	3.591	1.488-	0.004
mellitus		7.553			8.665	
Pregnancy	6.137	1.107-	0.038	5.839	1.035-	0.046
		34.023			32.935	
Symptoms						

Asymptomatic	reference		reference	reference		reference
Pre-symptomatic	3.828	1.505-	0.005	4.015	1.559-	0.004
		9.741			10.337	
Symptomatic	1.847	0.829-	0.134	1.983	0.880-	0.099
		4.115			4.469	

OR: Odds ratio, CI: Confidence interval

DISCUSSION

Despite the increase in vaccination against COVID-19, the number of confirmed cases worldwide has been increasing due to the easing of quarantine measures, waning of vaccination immunity, and the emergence of new SARS-CoV-2 variants.[1] Because of the limitations of medical manpower and resources, such as hospital beds, at-home care was introduced in Korea. As this system was introduced for the first time in Korea, in this study, we aimed to explain the initial operating protocol and results.

In Korea, since the first COVID-19 outbreak in Daegu, in 2020, CTC have been operating in the face of the COVID-19 epidemic. Some facilities such as dormitories and hotels were converted to isolation units for patients with COVID-19, and a monitoring system for patients with the stationed medical staff was established. This system was flexibly operated according to the trend in the number of confirmed cases. To operate CTC, it is necessary to provide a space for isolation of patients and stay of medical staff. To prepare such facilities, a certain period was required, and after the increase in the number of confirmed cases, there were difficulties in arranging space and medical staff. In the case of a short-term epidemic, it could be managed, but as the epidemic became longer and the number of confirmed cases increased, like the fourth epidemic in Korea, there was a limit to the management through CTC. The

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4 medical system was saturated due to the number of confirmed cases and the increase in the
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6 number of patients with severe cases; therefore, the government of the Republic of Korea
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8 changed the policy for the management of patients with severe cases. As a result, at-home care
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10 was introduced in Korea. Before the fourth epidemic, some local governments operated at-
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12 home care by a public health center for certain patients, such as children and their parents, or
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14 patients who were healthy and young. As the fourth epidemic began, at-home care expanded
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16 the target and region to all over the country and was managed by the hospital from October
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18 2021.
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24 With the COVID-19 pandemic, some countries, including the United States, quarantined
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26 asymptomatic or mild patients in their homes, without hospitalization.[11–14] At-home care in
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28 Korea was a system that monitored patients twice a day over the phone. Procurement of
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30 necessary supplies and transfer systems were established and managed. Through this system,
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32 some solutions have been suggested for medical problems that could be missed due to simple
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34 home isolation alone.
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39 Entering quarantine facilities, such as CTC, due to COVID-19 could cause psychological
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41 problems. Approximately 30% of patients admitted to CTC complained of psychological
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43 problems due to isolation in an unfamiliar environment.[8] In particular, in the case of pediatric
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45 patients, when considering psychological factors and diagnosis time after symptom onset,
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47 which might be the transmission period had passed, isolation in CTC or hospital was somewhat
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49 disadvantageous.[7] At-home care compensated for the psychological disadvantages of the
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51 CTC by maintaining quarantine in a familiar environment, especially with family.
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56 Respiratory symptoms such as cough, sputum, sore throat, fever, and anosmia were symptoms
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4 of COVID-19.[4,5,15] In this study, cough was the most common symptom for which
5 medicines were prescribed. Most prescribed medicines were for respiratory symptoms, but
6 there were also cases of digestive symptoms, conjunctivitis, or sleep disorder. As the COVID-
7 19 epidemic prolonged and many patients were treated under at-home care, strategic
8 preparedness was required so that medicines for respiratory symptoms and for other possible
9 symptoms could be smoothly supplied to the patients. In some cases, there was a shortage of
10 medications that were being taken in cases of underlying conditions. This indicated that during
11 the quarantine period, there may be a need for an alternative to the prescription of the medicine
12 that was currently being taken, such as a proxy prescription.
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26 Elderly patients and pregnant women have a high risk of acute exacerbation and severity.[16–
27 18] Comorbidities such as hypertension and DM were other risk factors for disease aggravation
28 in patients with COVID-19.[18] In this study, DM and pregnancy were the risk factors for
29 transfer, along with the pre-symptomatic status. Although age did not show a significant
30 association with the transfer, 30.5% of the transferred patients were older than 60 years. At-
31 home care patients with underlying conditions or old age needed more thorough management
32 with caution.
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44 In this study, 5.8% of the patients were transferred to the CTC or hospitals. In a previous study
45 of CTC that treated asymptomatic or mild COVID-19 patients, the transfer rate ranged from
46 0.7% to 10.3%.[4,6,19,20] Patients transferred for worsening of symptoms requested a transfer
47 at a median of 5 days after symptom onset and a median of 3 days from diagnosis. The duration
48 from diagnosis to transfer was different on comparison with a previous study reporting a
49 median of 3.5 days to 11 days.[4,6,15,19] This duration was shorter in the present study
50 because all patients with COVID-19 were under at-home care as a basic treatment, the
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4 proportion of patients who wished to be transferred to the CTC or hospitals and that of patients
5 who faced difficulties in self-isolation was as high as 22.0%. The patients were transferred
6 quickly after the diagnosis. In approximately 55% of cases in this study, transfer requests were
7 made within 5 days of symptom onset. However, in the remaining 45%, symptoms worsened
8 6 days after symptom onset. Some reported that symptoms were aggravated between 4 and 14
9 days after symptom onset.[21,22] At the beginning of at-home care, monitoring was maintained
10 for 10 days from symptom onset. However, the monitoring duration was subsequently modified
11 to 7 days and additional monitoring for 3 days is required was determined depending on
12 symptoms. Patients with risk factors were monitored thoroughly, as there were some patients
13 who needed to be transferred to the CTC or hospitals even at the end of monitoring (7 days
14 post-management).

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31 This system was not a monitoring and treatment system that checks the patient in real-time.
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33 The worsening of symptoms may have been missed. This risk was even greater in patients who
34 received at-home care alone. In addition, if the patient did not feel any symptoms even when
35 the condition worsened, the patient might have been left unattended. Difficulty in responding
36 to emergent situations was another problem. Since the patient was not treated in the same space
37 as medical personnel, it took time to directly contact the medical personnel, even if the
38 symptoms were monitored. In addition, after confirming the transfer, it took time to assign and
39 implement emergency measures. Unlike CTC, if a transfer was delayed, proper medical
40 measures such as oxygen supply were also delayed, which could prove to be fatal to patients.
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42 Therefore, there is a need for a system that secures and utilizes an ambulance and an available
43 emergency bed for at-home care patients in advance.

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4 basic treatment policy has been switched to at-home care, the number of patients receiving at-
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6 home care is continuously increasing. Because at-home care was a system in which medical
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8 staff directly interviewed patients twice a day over the phone, medical personnel were needed
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10 for this. Administrative personnel were also required to allocate patients, deliver supplies, and
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12 deliver drugs through prescriptions. In the beginning, management of patients with the help of
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14 assigned medical personnel was possible, but as the number of patients increased, management
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16 by the existing staff became difficult. This may lead to difficulties in identifying patients and
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18 responding to patients. In preparing for the continuing epidemic, measures should be taken on
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20 how to procure the required manpower.
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26 This study had some limitations. First, this was a single-center study. As at-home care has been
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28 expanded to cover the entire nation and all patients confirmed of having COVID-19, it is
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30 necessary to analyze the additional data of the results of at-home care. Second, this study
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32 analyzed the result of the early phase of at-home care. It was a point in time when the setting
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34 was not completely established. Thus, additional system supplementation is required.
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41 **CONCLUSION**

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43 Due to the increase in the number of confirmed cases beyond those that medical facilities could
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45 handle at-home care was an unavoidable option. For safe at-home care, patients with risk
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47 factors such as DM require more careful monitoring, and it is necessary to prepare for an
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49 appropriate response to the emergency.
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Acknowledgement

None

Contributors

YBS conceptualized the manuscript, manuscript editing. JJP contributed to data curation, data analysis and manuscript writing. JL, SHN and YKC contributed to acquisition of data. All authors have read and approved the submission.

Funding

This paper is supported by the Korea National Research Foundation (NRF) grant funded by the Korean government (MEST) (NRF-2021M3E5E308120711)

Competing Interests

None declared.

Patient consent for publication

Not required

Ethics approval

The study was approved by the Institutional Review Board (IRB) of Kangnam Sacred Heart Hospital (IRB No.: 2021-11-035-001), and the requirement for informed consent was waived.

Data availability statement

No data available.

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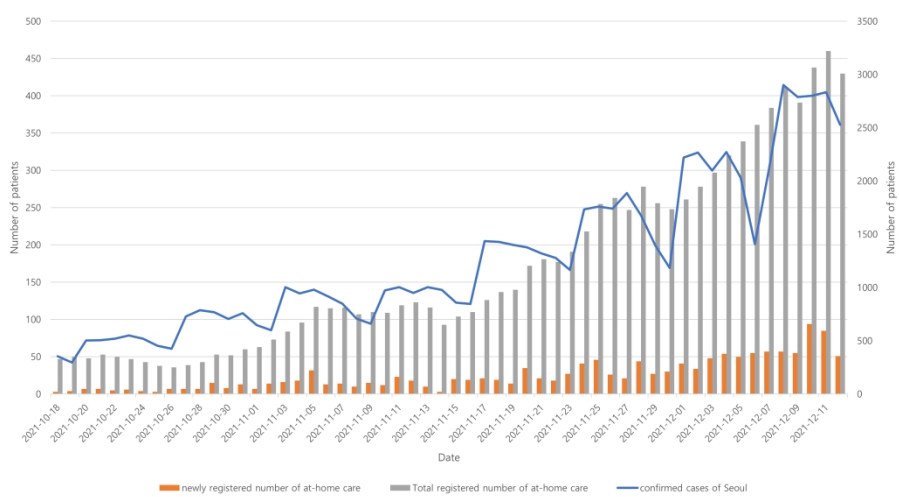
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4 **Figure legend**
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7 Figure 1. Trends of number of patients with COVID-19 in this study and in Seoul, South Korea
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Trends of number of patients with COVID-19 in this study and in Seoul, South Korea

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STROBE Statement—checklist of items that should be included in reports of observational studies

	Item No.	Recommendation	Page No.	Relevant text from manuscript
Title and abstract	1	(a) Indicate the study's design with a commonly used term in the title or the abstract	2	Retrospective cohort study
		(b) Provide in the abstract an informative and balanced summary of what was done and what was found	2, 3	abstract
Introduction				
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	4	introduction
Objectives	3	State specific objectives, including any prespecified hypotheses	4, 5	introduction
Methods				
Study design	4	Present key elements of study design early in the paper	6	Materials and methods-study design, setting and study population
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	6,9	Materials and methods-study design, setting and study population Materials and methods - data collection and statistical analysis
Participants	6	(a) <i>Cohort study</i> —Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up <i>Case-control study</i> —Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls <i>Cross-sectional study</i> —Give the eligibility criteria, and the sources and methods of selection of participants	7, 8	Materials and methods - criteria for enrolment and and release from quarantine
		(b) <i>Cohort study</i> —For matched studies, give matching criteria and number of exposed and unexposed <i>Case-control study</i> —For matched studies, give matching criteria and the number of controls per case		

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Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	9	Materials and methods - data collection and statistical analysis
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	9	Materials and methods - data collection and statistical analysis
Bias	9	Describe any efforts to address potential sources of bias		
Study size	10	Explain how the study size was arrived at	6	Materials and methods-study design, setting and study population

Continued on next page

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Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why		
Statistical methods	12	(a) Describe all statistical methods, including those used to control for confounding	9	Materials and methods - data collection and statistical analysis
		(b) Describe any methods used to examine subgroups and interactions		
		(c) Explain how missing data were addressed		
		(d) <i>Cohort study</i> —If applicable, explain how loss to follow-up was addressed <i>Case-control study</i> —If applicable, explain how matching of cases and controls was addressed <i>Cross-sectional study</i> —If applicable, describe analytical methods taking account of sampling strategy		
		(e) Describe any sensitivity analyses		
Results				
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	11	results
		(b) Give reasons for non-participation at each stage	11	results
		(c) Consider use of a flow diagram		
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	11	Results-Table1
		(b) Indicate number of participants with missing data for each variable of interest	11	results
		(c) <i>Cohort study</i> —Summarise follow-up time (eg, average and total amount)	11,12	Results-Table 1
Outcome data	15*	<i>Cohort study</i> —Report numbers of outcome events or summary measures over time	11-13	Results-Table 1
		<i>Case-control study</i> —Report numbers in each exposure category, or summary measures of exposure		
		<i>Cross-sectional study</i> —Report numbers of outcome events or summary measures		
Main results	16	(a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	11-18	Results-Table 4
		(b) Report category boundaries when continuous variables were categorized		
		(c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period		

Continued on next page

Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses		
Discussion				
Key results	18	Summarise key results with reference to study objectives	18	discussion
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	22	discussion
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	8-22	discussion
Generalisability	21	Discuss the generalisability (external validity) of the study results	8-22	discussion
Other information				
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	23	funding

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at <http://www.plosmedicine.org/>, Annals of Internal Medicine at <http://www.annals.org/>, and Epidemiology at <http://www.epidem.com/>). Information on the STROBE Initiative is available at www.strobe-statement.org.

BMJ Open

The protocol and clinical characteristics of patients under "at-home care" for coronavirus disease 2019 in South Korea: a retrospective cohort study

Journal:	<i>BMJ Open</i>
Manuscript ID	bmjopen-2022-061765.R1
Article Type:	Original research
Date Submitted by the Author:	21-Apr-2022
Complete List of Authors:	Park, Jin Ju; Hallym University College of Medicine, Department of Internal Medicine Seo, Yu Bin; Hallym University College of Medicine, Department of Internal Medicine Lee, J; Hallym University College of Medicine, Department of Internal medicine Na, Sun Hee; Hallym University College of Medicine, Department of Internal Medicine Choi, Young Kyun; Chungnam National University College of Medicine, Department of Internal Medicine
Primary Subject Heading:	Infectious diseases
Secondary Subject Heading:	Epidemiology, Public health
Keywords:	COVID-19, PUBLIC HEALTH, INFECTIOUS DISEASES

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4 **Title**

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7 **The protocol and clinical characteristics of patients under “at-home care” for**
8
9 **coronavirus disease 2019 in South Korea: a retrospective cohort study**

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Word count: 3433

22 ABSTRACT

23 Objective

24 As the number of patients with coronavirus disease 2019 (COVID-19) increased, at-home care
25 was introduced for the first time in South Korea. This study aimed to analyze the characteristics
26 and outcomes of patients who were treated under at-home care.

27 Design, setting, and participants

28 This retrospective cohort study targeted patients under at-home care for COVID-19 in
29 Yeoungdeungpo-gu in Seoul, Korea, from October 18, 2021, to December 12, 2021. The public
30 health center selected eligible patients for at-home care and registered with our institution.
31 Nurses monitored patients and doctors decided to transfer healthcare facilities and release the
32 quarantined patients according to their symptoms.

33 **Outcome Measures:** Patient characteristics during the course of at-home care

34 Results

35 A total of 1,422 patients were enrolled and 9,579 patient days were managed. Most patients
36 were aged 60 years and older (22.7% [n=323]), and 82.8% did not have underlying conditions.
37 The median length of care for patients was 8 days (interquartile range: 5-10). During the study
38 period, 986 (69.3%) patients were released from quarantine, 82 (5.8%) patients were
39 transferred to facilities, and 354 (24.9%) patients were still under at-home care at the end of
40 the study period. The most common cause of transfer was sustained fever (n = 30, 36.6%),
41 followed by dyspnea and desaturation (n = 17, 20.7%). Factors associated with transfer were
42 diabetes (odds ratio [OR]: 3.591, 95% confidence interval [CI]: 1.488-8.665, *P* = 0.004),
43 pregnancy (OR: 5.839, 95% CI: 1.035-32.935, *P* = 0.046), and being pre-symptomatic at

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4 44 diagnosis (OR: 4.015, 95% CI: 1.559-10.337, $P = 0.004$).
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7 45 **Conclusions**
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10 46 There were no specific problems related to patient safety when operating at-home care. Patients
11
12 47 with risk factors such as diabetes were more likely to be transferred to healthcare facilities. For
13
14
15 48 safe at-home care, it is necessary to prepare for an appropriate response to the emergency.
16

17
18 49 **Keywords:** COVID-19; home care; protocol; outcome
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23 51 **Strengths and limitations of this study:**
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- 25
26 52 • The study emphasizes the need to prepare for an appropriate response to an
27
28 53 emergency during at-home care.
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31 54 • This was a single-center retrospective cohort study.
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34 55 • This study depicted the early phase of at-home care for patients with COVID-
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57 INTRODUCTION

58 Severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) was first discovered in
59 Wuhan, China in December 2019, and since the World Health Organization announced the
60 pandemic in March 2020, there have been approximately 290 million confirmed cases of
61 coronavirus disease 2019 (COVID-19) worldwide, as of December 2021.[1,2] With the
62 development of vaccines, the number of confirmed cases in the United States and Europe
63 seemed to be decreasing, but due to the easing of quarantine measures and the presentation of
64 new variants, the number of confirmed cases skyrocketed again. There was no difference in the
65 domestic situation. With the start of vaccination, the overall quarantine level was relieved.
66 However, subsequently, a fourth epidemic occurred in Korea. In addition, emerging new
67 variants have led to the updating of new confirmed cases every day.[3]

68 During each epidemic situation, the medical system faced a crisis, and it was accompanied by
69 difficulties in allocating medical personnel, supplies, and beds. During the initial epidemic,
70 community treatment centers (CTC) for asymptomatic or mild patients were operated to fill
71 the medical gap in Korea.[4–6] As the epidemic progressed, it became difficult to cope with
72 the increasing number of patients with COVID-19 with CTCs alone. The occurrence of
73 pediatric and psychological problems was another challenge for the CTC setting.[7,8]

74 As the COVID-19 pandemic protracted, the Korean government modified its policy for
75 management of critically ill patients with COVID-19. The domestic metropolitan area
76 introduced at-home care as an alternative to a deficient medical system. This is the first home
77 healthcare system for the management and monitoring of patients suffering from infectious
78 diseases in Korea. To overcome the current COVID-19 pandemic and prepare for a new novel
79 infectious disease, a well-established at-home care system is required. In this study, we aimed

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4 80 to introduce an at-home care protocol that is being implemented through our institution and
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6 81 analyze the characteristics and outcomes of patients under at-home care during the COVID-19
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9 82 pandemic.

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13 14 15 84 **MATERIALS AND METHODS**

16 17 18 85 **Study design, setting, and study population**

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21 86 This was a retrospective cohort study that used medical records. Kangnam Sacred Heart
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23 87 Hospital is a secondary university hospital with 572 beds located in Yeongdeungpo-gu, Seoul,
24
25 88 South Korea. This institution provides internal medicine, surgery, and pediatric intensive care
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28 89 units, as well as an emergency center and outpatient department. This institution is responsible
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30 90 for treating patients mainly in the local constituency. Our institution signed an agreement with
31
32 91 Yeongdeungpo-gu administration to become a provider of at-home medical care on October 5,
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34 92 2021, and started operating as such on October 18, 2021. All patients under at-home care via
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37 93 Kangnam Sacred Heart Hospital between October 18, 2021, and December 12, 2021, were
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39 94 included in this study.

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43 44 45 96 **Criteria for patient enrollment and release from quarantine**

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48 97 In Korea, COVID-19 was designated as a Class 1 legal infectious disease, which required all
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50 98 confirmed patients to report to public health authorities and to be quarantined for a set period.
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52 99 The person in charge of the public health center conducted an interview of all patients with
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55 100 confirmed diagnoses of COVID-19 and determined whether at-home care was appropriate or
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57 101 if they required hospital admission. Patients who could be treated at home and who provided

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4 102 consent to public health were registered at our institution as at-home care patients.
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7 103 On November 26, 2021, policies for the care of patients with COVID-19 were changed, as
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9 104 were the criteria for at-home care. Before this date, asymptomatic confirmed COVID-19
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11 105 patients and those with mild symptoms under 70 years of age with no risk of hospitalization
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13 106 were eligible to receive at-home care. From November 26, 2021, onward, all patients were
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15 107 eligible to receive at-home care and were admitted to healthcare facilities only if there was a
16
17 108 need for hospitalization.
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20 21 22 109 **Enrollment criteria**

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24 110 Before November 26, 2021, the Korea Centers for Disease Control and Prevention classified
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26 111 patients with asymptomatic and mild symptoms under 70 years of age as candidates for at-
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28 112 home care, following consent, except in the presence of the following risk factors for
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30 113 hospitalization: mental change after symptom onset of COVID-19, dyspnea, uncontrolled fever
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32 114 with antipyretics, uncontrolled diabetes mellitus (DM), hemodialysis, patients treated for
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34 115 chronic lung disease, asthma, heart failure, coronary artery disease, patients under
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36 116 chemotherapy or immunosuppressant, uncontrolled symptomatic psychiatric disease,
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38 117 bedridden states, obese (body mass index > 30), pregnant with symptoms such as abdominal
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40 118 pain, labor, vaginal bleeding, childhood or with a high risk of dyspnea, cyanosis, chest
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42 119 depression, poor oral intake, or dehydration, diagnosed with chronic lung disease/cardiac
43
44 120 disease/metabolic disease/abnormal immune system, under immunosuppressant, respiratory
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46 121 function or excretion problem, or risk of aspiration. In patients over 60 years, only those who
47
48 122 had been vaccinated were registered for at-home care. Patients in need of care, such as minors
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50 123 and those with disabilities, were required to be accompanied by a caregiver.[9] The exclusion
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52 124 criteria were as follows: 1) those who lived in a residential environment vulnerable to infection
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4 125 due to difficulty in distancing or 2) when communication for non-face-to-face healthcare and
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6 126 quarantine management was difficult for the patient or caregiver.
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9 127 From November 26, 2021, patients with a confirmed COVID-19 diagnosis were all allocated
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11 128 to at-home care, except in the following cases: 1) those who had the aforementioned risk factors
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13 129 for hospitalization, 2) those who lived in a residential environment vulnerable to infection, 3)
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15 130 individuals that were minors, disabled, or over the age of 70 years who required care but could
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17 131 not be quarantined together with a caregiver, 4) those who were deemed ineligible for treat
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19 132 with at-home care by the local government head (e.g. owing to a legal problem, etc.).[10]
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23 24 133 **Criteria for release from quarantine**

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27 134 Symptomatic patients were released from quarantine 10 days after symptom onset.[9]
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29 135 Asymptomatic patients were released from quarantine 10 days after diagnosis. The quarantine
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31 136 date was extended depending on the occurrence of symptoms, and the final decision for release
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33 137 was made by the medical staff.
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38 39 40 139 **Intervention**

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43 140 Kangnam Sacred Heart Hospital operated at-home care by targeting patients with COVID-19
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45 141 residing in Yeongdeungpo-gu. The at-home care program involved four medical doctors and
46
47 142 five nurses in one monitoring room. They operated during the day and used an on-call system
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49 143 at night. One doctor was in-charge per day, but a backup doctor was designated in case of an
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51 144 emergency. Nurses worked in two shifts, with two nurses during the daytime and evening and
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53 145 one during the night for the on-call system.
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57 146 The Yeondeungpo-gu public health center classified patients with COVID-19 for at-home care
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4 147 according to the enrollment criteria and supplied items necessary for at-home care such as
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6 148 antipyretics, an oxygen saturation monitor, a thermometer, and phone numbers of related
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9 149 medical institutions. The patients to be managed were registered as outpatients with assigned
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11 150 doctors every day so that prescriptions were available if needed. The list of patients under at-
12
13 151 home care was secured through the public health center and updated daily.

16 152 The monitoring room was equipped with computers, monitors, and smartphones. Patients
17
18 153 checked their blood pressure and body temperature and uploaded the data via smartphone
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20 154 applications. Nurses called the patient at 9 a.m. and 5 p.m. every day to check the patient's
21
22 155 vital signs and symptoms and update patient information on electronic health records. If the
23
24 156 patient had symptoms and wanted to take medication, the doctor interviewed the patient and
25
26 157 prescribed the medicine. The prescription was sent to the public health center by fax. After
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28 158 prescribing the medicine at the pharmacy, the person in charge of the public health center
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30 159 delivered the medicine to the patient's house. If the patient had persistent fever, desaturation,
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32 160 or worsening clinical symptoms, the doctor interviewed the patient and decided whether to
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34 161 transfer the patient to another facility at the discretion of that doctor, such as a CTC or hospital,
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36 162 according to severity. The public health center assigned an ambulance and medical institution
37
38 163 and transported the patient accordingly.

44 164 The medical staff checked the list of patients who were subject to release from quarantine daily
45
46 165 and assessed whether it was possible to release them from quarantine according to the criteria.
47
48 166 When those under quarantine were released, at-home care and monitoring also ended. The
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50 167 results were then reported to the public health center.
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57 169 **Data collection and statistical analysis**

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4 170 Data regarding patient characteristics such as age, sex, enrollment date, release from quarantine
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6 171 date, transfer date (if transferred), symptoms, and medical prescription were collected through
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9 172 a retrospective medical record review.

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11 173 Continuous variables were presented as mean \pm standard deviation (SD) or median
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14 174 (interquartile range [IQR]), as appropriate. Statistical significance was assessed using the chi-
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16 175 squared test and Fisher's exact test for categorical variables. Non-categorical variables were
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18 176 tested using the two-sided unpaired t-test or Mann–Whitney U test. The factors associated with
19
20 177 transfer were calculated using a logistic regression model. Statistical significance was set at P
21
22
23 178 < 0.05 . Statistical analyses were performed using SPSS ver. 27 (IBM, Armonk, NY).

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27 28 29 180 **Patient and public involvement**

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32 181 None (not applicable to this type of study).

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36 37 183 **RESULTS**

38 39 40 184 **Baseline characteristics of study population**

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43 185 During the study period, 1,453 patients were registered. Three patients moved to another
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45 186 district, and twenty-eight patients were excluded from at-home care on the day of admission
46
47 187 due to other causes of admission, such as severe symptoms at diagnosis. A total of 1,422
48
49 188 patients and 9,574 patient days were managed under at-home care at Kangnam Sacred Heart
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51 189 Hospital. The number of patients managed daily is shown in Figure 1.

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55 190 Among 1,422 patients, 725 (51.0%) were male, and the median age was 40 (IQR: 27-58, range:
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57 191 0-87) years (Table 1). Most patients were over 60 years (22.7% [n = 323]), followed by those

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4 192 in their 30s (18.5% [n = 263]). Most (n = 1,177; 82.8%) did not have underlying conditions.
5
6 193 Hypertension (n = 153; 10.8%) was the most common comorbidity. Approximately 16.4% (n
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8
9 194 = 233) of patients under at-home care were asymptomatic. There were 209 cases of drug
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11 195 prescriptions in 176 (12.4%) patients. On average, 3.7 ± 3.73 (range: 0-16) prescriptions were
12
13 196 requested per day. Symptoms for the prescribed drugs are described in Table 2. The most
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15
16 197 common symptom was cough (n = 115; 55.8%), followed by sputum (n = 62; 30.1%) and sore
17
18 198 throat (n = 54; 26.2%). Night calls occurred in 68 cases which was an average of 1.2 ± 1.64
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20 199 (range: 0-6 cases) night calls per day.
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201 **Table 1. Baseline characteristics of patients under at-home care system (n = 1422)**

Characteristics	Total (N = 1422) N (%)	Released from quarantine (N = 986) N (%)	Transferred (N = 82) N (%)	P-value
Sex				0.873
Male	725 (51.0)	508 (51.5)	43 (52.4)	
Female	697 (49.0)	478 (48.5)	39 (47.6)	
Mean age, years (range)	40 (0-87)	40 (0-83)	45 (1-87)	0.051
0-9	156 (11.0)	109 (11.1)	3 (3.7)	
10-19	122 (8.6)	73 (7.4)	10 (12.2)	
20-29	151 (10.6)	112 (11.4)	8 (9.8)	
30-39	263 (18.5)	194 (19.7)	14 (17.1)	

40-49	186 (13.1)	120 (12.2)	11 (13.4)	
50-59	221(15.5)	152 (15.4)	11 (13.4)	
≥60	323 (22.7)	225 (22.9)	25 (30.5)	
Underlying conditions				
Hypertension	153 (10.8)	99 (10.0)	15 (18.3)	0.020
Diabetes	43 (3.0)	28 (2.8)	7 (8.5)	0.005
Thyroid disease	22 (1.5)	17 (1.7)	0 (0)	0.231
Psychiatric disorder	12 (0.8)	10 (1.0)	1 (1.2)	0.860
Pregnancy	6 (0.4)	4 (0.4)	2 (2.4)	0.018
Others*	53 (3.7)	26 (2.6)	5 (6.1)	
None	1177 (82.8)	820 (83.2)	60 (73.2)	0.022
Symptoms				0.009
Asymptomatic	233 (16.4)	159 (16.1)	7 (8.5)	
Pre-symptomatic	160 (11.3)	89 (9.0)	15 (18.3)	
Symptomatic	1029 (72.4)	738 (74.8)	60 (73.2)	
Medicine prescription	176 (12.4)	117 (11.9)	21 (25.6)	0.020
Transfer to healthcare facilities	82 (5.8)			
Median days from symptoms to diagnosis, days (IQR)	2 (1-4)	2 (1-4)	2 (1-3.75)	0.307
Median days from diagnosis to	1 (0-1)	1 (0-2)	0 (0-1)	< 0.001

management, days					
(IQR)					
Median management days **,	8 (5-10)	8 (6-10)	3 (2-4.25)	< 0.001	
days (IQR)					

202 IQR: interquartile range

203 * Epilepsy, autoimmune disease, liver disease, asthma, bronchiectasis, angina, cerebrovascular
204 disease, ulcerative colitis

205 ** Release from quarantine and transferred patients, excluded under management

206

207 **Table 2. Symptoms for prescription medication (n = 209)**

Symptoms*	No. (%)
Cough	115 (55.8)
Sputum	62 (30.1)
Sore throat	54 (26.2)
Nasal congestion	38 (18.4)
Rhinorrhea	33 (16.0)
Fever	17 (8.3)
Headache	14 (6.8)
Myalgia	8 (3.9)
Conjunctivitis	7 (3.4)
Gastrointestinal symptoms	7 (3.4)

Other**	10 (4.9)
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208 * Allowed duplicates

209 ** Sleep disorder, febrile sense, underlying disease

210

211 The median length from symptoms to diagnosis was 2 days (IQR: 1-4), and 1 day (IQR: 0-1)
 212 from diagnosis to management. The median length of care for patients was 8 days (IQR: 5-10).
 213 During the study period, 986 (69.3%) patients were released from quarantine, 82 (5.8%)
 214 patients were transferred to CTCs or hospitals, and 354 (24.9%) patients were still under at-
 215 home care when the study period ended. No patients under at-home care died during the study
 216 period.

217 **Characteristics according to transfer**

218 A total of 83 (5.8%) patients were transferred. Sex and age did not differ significantly according
 219 to the transfer (Table 1). Among the transferred patients, 52.4% (n = 43) were male, and
 220 patients over 60 years (n = 25; 30.5%) were most frequently transferred. Patients with
 221 comorbidities were significantly more likely to be transferred than those who were released
 222 from quarantine (25.8% vs. 16.8%, $P = 0.022$). The proportion of patients with hypertension
 223 and DM was significantly higher in transferred patients (10.0% vs. 18.3%, $P = 0.020$, 2.8% vs.
 224 8.5%, $P = 0.005$). The proportion of pregnant women was significantly higher in the transferred
 225 patients (0.4% vs. 2.4%, $P = 0.018$). The median management duration of at-home care was 8
 226 days (IQR: 6-10) for release from quarantine and 3 days (IQR: 2-4.25) for transferred patients.
 227 The most common cause of transfer was sustained fever (n = 30; 36.6%) (Table 3). Seventeen
 228 patients (20.7%) were transferred because of dyspnea, and their oxygen saturation was less

229 than 90%. The time from symptom onset to transfer request was a median 5 days (IQR: 4-8),
 230 and a median 3 days (IQR: 2-5) were required from diagnosis to transfer request. Most transfers
 231 (n = 61; 75.5%) were made on the same day as the transfer requests. For 21 (25.6%) patients,
 232 it took 1 day to allocate a bed after the request. One patient required 2 days and one patient
 233 required 3 days for transfer. All patients with dyspnea were transferred on the same day.

234

235 **Table 3. Reasons for transfer (n = 82)**

Reasons	No. (%)
Sustained fever	30 (36.6)
Dyspnea/desaturation	17 (20.7)
Patients wanted	13 (15.9)
Cough/chest pain	9 (11.0)
Resident with family	5 (6.1)
Minor	4 (4.9)
Aggravation of underlying disease	2 (2.4)
As caregiver	1 (1.2)
Old age	1 (1.2)

236

237 **Risk factors for transfer**

238 The factors associated with transfer are shown in Table 4. In univariate analysis, age and sex
 239 were not significantly associated with transfer. The presence of underlying disease (odds ratio
 240 [OR]: 1.811, 95% confidence interval [CI]: 1.081-3.035, $P = 0.024$), hypertension (OR: 2.006,

241 95% CI: 1.104-3.644, $P = 0.022$), DM (OR: 3.193, 95% CI: 1.350-7.553, $P = 0.008$), and
 242 pregnancy (OR: 6.137, 95% CI: 1.107-34.023, $P = 0.038$) were significantly associated with
 243 transfer. On multivariate analysis, we found no significant association of age or sex with
 244 transfer. DM (OR: 3.591, 95% CI: 1.488-8.665, $P = 0.004$), pregnancy (OR: 5.839, 95% CI:
 245 1.035-32.935, $P = 0.046$), and being pre-symptomatic (OR: 4.015, 95% CI: 1.559-10.337, $P =$
 246 0.004) were independent risk factors for transfer.

247 **Table 4. Factors associated with transfer**

Variables	Univariate analysis			Multivariate analysis		
	OR	95% CI	<i>P</i> -value	OR	95% CI	<i>P</i> -value
Female sex	0.964	0.614- 1.513	0.873	0.742	0.579- 1.476	0.742
Age						
0-9 years	0.385	0.100-	0.167	0.439	0.112-	0.238
10-19 years	1.918	1.491	0.191	2.169	1.723	0.126
20-29 years	reference	0.723-	reference	reference	0.804-	reference
30-39 years	0.982	5.086	0.982	0.957	5.849	0.924
40-49 years	0.605		0.605	1.371		0.521
50-59 years	0.978	0.411-	0.978	0.961	0.384-	0.937
>60 years	0.300	2.483	0.300	1.346	2.386	0.518
		0.498-			0.523-	
		3.306			3.596	
		0.395-			0.360-	
		2.601			2.566	

			0.677-			0.547-	
			3.544			3.315	
Underlying	1.811	1.081-	0.024	0.662	0.219-	0.465	
disease		3.035			1.999		
Hypertension	2.006	1.104-	0.022	2.106	0.682-	0.196	
		3.644			10.208		
Diabetes	3.193	1.350-	0.008	3.591	1.488-	0.004	
mellitus		7.553			8.665		
Pregnancy	6.137	1.107-	0.038	5.839	1.035-	0.046	
		34.023			32.935		
Symptoms							
Asymptomatic	reference		reference	reference		reference	
Pre-	3.828	1.505-	0.005	4.015	1.559-	0.004	
symptomatic		9.741			10.337		
Symptomatic	1.847	0.829-	0.134	1.983	0.880-	0.099	
		4.115			4.469		

OR: odds ratio, CI: confidence interval

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250 DISCUSSION

251 Despite the increase in vaccination against COVID-19, the number of confirmed cases
 252 worldwide has been increasing due to the easing of quarantine measures, waning vaccination
 253 immunity, and the emergence of new SARS-CoV-2 variants.[1] Because of the limitations of
 254 medical manpower and resources, such as hospital beds, at-home care was introduced in Korea.

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4 255 As this system was introduced for the first time in Korea, we aimed to explain the initial
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6 256 operating protocol and results.
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9 257 In Korea, since the first COVID-19 outbreak in Daegu in 2020, CTCs have been operating in
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11 258 the face of the COVID-19 epidemic. Some facilities, such as dormitories and hotels, were
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14 259 converted to quarantine units for patients with COVID-19, and a monitoring system for patients
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16 260 with stationed medical staff was established. This system was flexibly operated according to
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18 261 trends in the number of confirmed cases. To operate a CTC, it is necessary to provide a space
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20 262 for both quarantining patients and working medical staff. To prepare such facilities, a certain
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22 263 period was required, and after the increase in the number of confirmed cases, there were
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24 264 difficulties in arranging space and medical staff. This could be managed in the case of a short-
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26 265 term epidemic, but as the epidemic became longer and the number of confirmed cases increased,
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28 266 like during the fourth epidemic in Korea, there was a limit to the management through CTCs.
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30 267 The medical system was saturated due to the number of confirmed cases and the increase in
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32 268 the number of patients with severe cases; therefore, the government of the Republic of Korea
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34 269 changed the policy for the management of severely ill patients. As a result, at-home care was
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36 270 introduced in Korea. Before the fourth epidemic, some local governments operated at-home
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38 271 care by a public health center for certain patients, such as children and their parents, or patients
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40 272 who were healthy and young. As the fourth epidemic began, at-home care expanded its target
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42 273 to all over the country and was managed by hospitals from October 2021.
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50 274 With the COVID-19 pandemic, some countries, including the United States, quarantined
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52 275 asymptomatic or mild patients in their homes without hospitalization.[11–14] At-home care in
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54 276 Korea was a system that monitored patients twice a day over the phone. Procurement of
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56 277 necessary supplies and transfer systems were established and managed. Through this system,
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4 278 some solutions have been suggested for medical problems that could be missed due to simple
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6 279 home quarantine alone.

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10 280 Entering quarantine facilities, such as a CTC, due to COVID-19 could cause psychological
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12 281 problems. Approximately 30% of patients admitted to a CTC complained of psychological
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14 282 problems due to quarantine in an unfamiliar environment.[8] In particular, when considering
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16 283 psychological factors and diagnosis time after symptom onset in pediatric patients, which might
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18 284 be after the transmission period had passed, quarantine in a CTC or hospital was somewhat
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20 285 disadvantageous.[7] At-home care compensated for the psychological disadvantages of CTCs
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22 286 by maintaining quarantine in a familiar environment, especially with family.

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27 287 Respiratory symptoms such as cough, sputum, sore throat, fever, and anosmia were symptoms
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29 288 of COVID-19.[4,5,15] In this study, cough was the most common symptom for which
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31 289 medicines were prescribed. Most prescribed medicines were for respiratory symptoms, but
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33 290 there were also cases of digestive symptoms, conjunctivitis, or sleep disorder. As the COVID-
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35 291 19 epidemic persisted and many patients were treated under at-home care, strategic
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37 292 preparedness was required so that medicines for respiratory symptoms and other possible
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39 293 symptoms could be smoothly supplied to patients. In some cases, patients ran out of
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41 294 medications that were being taken in cases of underlying conditions. This indicated that, during
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43 295 the quarantine period, there may be a need for an alternative to the prescription of medicines
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45 296 for underlying conditions such as hypertension.

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51 297 Elderly patients and pregnant women have a high risk of acute exacerbation and severity.[16–
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53 298 18] Comorbidities such as hypertension and DM were other risk factors for disease aggravation
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55 299 in patients with COVID-19.[18] In this study, DM and pregnancy were risk factors for transfer,
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4 300 along with pre-symptomatic status. Although age was not significantly associated with transfer,
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6 301 30.5% of transferred patients were older than 60 years. At-home care patients with underlying
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9 302 conditions or old age needed more thorough management with caution.

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12 303 In this study, 5.8% of patients were transferred to CTCs or hospitals. In a previous study of
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14 304 CTCs that treated asymptomatic or mild COVID-19 patients, the transfer rate ranged from 0.7%
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17 305 to 10.3%.[4,6,19,20] Patients transferred for worsening of symptoms requested a transfer at a
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19 306 median of 5 days after symptom onset and a median of 3 days from diagnosis. The duration
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21 307 from diagnosis to transfer was different on comparison with a previous study reporting a
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23 308 median of 3.5 days to 11 days.[4,6,15,19] This duration was shorter in the present study
24
25 309 because all patients with COVID-19 were under at-home care as a basic treatment, and the
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27 310 proportion of patients who wished to be transferred to a CTC or hospital and that of patients
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29 311 who faced difficulties in self-quarantine was as high as 15.9% and 6.1%, respectively. Patients
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31 312 were transferred quickly after diagnosis. In approximately 55% of cases in this study, transfer
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33 313 requests were made within 5 days of symptom onset. However, in the remaining 45%,
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35 314 symptoms worsened 6 days after symptom onset. Some reported that symptoms were
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37 315 aggravated between 4 and 14 days after symptom onset.[21,22] Patients with risk factors were
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39 316 monitored thoroughly, as there were some patients who needed to be transferred to a CTC or
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41 317 hospital even at the end of monitoring.

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48 318 This system was not a monitoring and treatment system that checks a patient in real time. The
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50 319 worsening of symptoms may have been missed. This risk was even greater in patients who
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52 320 received at-home care alone. In addition, if the patient did not feel any symptoms even when
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54 321 the condition worsened, the patient might have been left unattended. Difficulty in responding
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56 322 to emergent situations was another problem. Since the patient was not treated in the same space

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4 323 as medical personnel, it took time to directly contact the medical personnel, even if the
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6 324 symptoms were monitored. In addition, after confirming the transfer, it took time to assign and
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9 325 implement emergency measures. Unlike in a CTC, if a transfer was delayed, proper medical
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11 326 measures such as oxygen supply were also delayed, which could prove to be fatal to patients.
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13 327 Therefore, there is a need for a system that secures and utilizes an ambulance and an available
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16 328 emergency bed for at-home care patients in advance.

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19 329 Currently, in a situation where the number of patients with COVID-19 has skyrocketed and the
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21 330 basic treatment policy has been switched to at-home care, the number of patients receiving at-
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23 331 home care is continuously increasing. Because at-home care was a system in which medical
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25 332 staff directly interviewed patients twice a day over the phone, medical personnel were needed
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27 333 for this. Administrative personnel were also required to allocate patients, deliver supplies, and
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29 334 deliver drugs through prescriptions. In the beginning, patient management with the help of
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31 335 assigned medical personnel was possible, but as the number of patients increased, management
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33 336 by the existing staff became difficult. This may lead to future difficulties in identifying patients
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35 337 and responding to patients. In preparing for the continuing epidemic, measures should be taken
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37 338 on how to procure the required manpower.

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40 339 This study had some limitations. First, this was a single-center study. As at-home care has been
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42 340 expanded to cover the entire nation and all patients confirmed to have COVID-19, it is
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44 341 necessary to analyze additional data of the results of at-home care. Second, this study analyzed
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46 342 the results of the early phase of at-home care, which was a point in time when the setting was
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48 343 not completely established. Thus, additional system supplementation is required.

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4 345 **CONCLUSION**
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7 346 Due to the increase in the number of confirmed cases beyond those that medical facilities could
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9 347 handle, at-home care was an unavoidable option. Patients with risk factors such as DM were
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11 348 more likely to be transferred to healthcare facilities. For safe at-home care, it is necessary to
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13 349 prepare for an appropriate response to the emergency.
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4 351 **Acknowledgements**

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10 353 **Contributors**

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13 354 YBS conceptualized and edited the manuscript. JJP contributed to data curation, data analysis,
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15 355 and manuscript writing. JL, SHN, and YKC contributed to acquisition of data. All authors have
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17 356 read and approved the submission.

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19
20 357 **Funding**

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22
23 358 This study was supported by the Korea National Research Foundation (NRF) grant funded by
24
25 359 the Korean government (MEST) (NRF-2021M3E5E308120711)

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28 360 **Competing interests**

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31 361 None declared.

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34 362 **Ethics approval**

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37 363 The study was approved by the Institutional Review Board (IRB) of Kangnam Sacred Heart
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39 364 Hospital (IRB No.: 2021-11-035-001), and the requirement for informed consent was waived.

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42 365 **Data availability statement**

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45 366 No data available.

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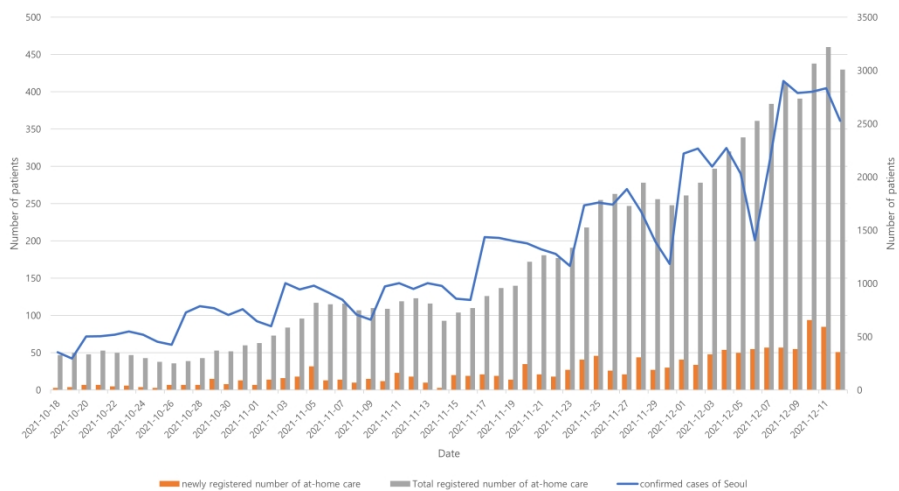
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439 **Figure legend**

440 Figure 1. Trends of number of patients with COVID-19 in this study and in Seoul, South Korea

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Trends of number of patients with COVID-19 in this study and in Seoul, South Korea

338x190mm (300 x 300 DPI)

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STROBE Statement—checklist of items that should be included in reports of observational studies

	Item No.	Recommendation	Page No.	Relevant text from manuscript
Title and abstract	1	(a) Indicate the study's design with a commonly used term in the title or the abstract	2	Retrospective cohort study
		(b) Provide in the abstract an informative and balanced summary of what was done and what was found	2, 3	abstract
Introduction				
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	4	introduction
Objectives	3	State specific objectives, including any prespecified hypotheses	4, 5	introduction
Methods				
Study design	4	Present key elements of study design early in the paper	6	Materials and methods-study design, setting and study population
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	6,9	Materials and methods-study design, setting and study population Materials and methods - data collection and statistical analysis
Participants	6	(a) <i>Cohort study</i> —Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up <i>Case-control study</i> —Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls <i>Cross-sectional study</i> —Give the eligibility criteria, and the sources and methods of selection of participants	7, 8	Materials and methods - criteria for enrolment and and release from quarantine
		(b) <i>Cohort study</i> —For matched studies, give matching criteria and number of exposed and unexposed <i>Case-control study</i> —For matched studies, give matching criteria and the number of controls per case		

Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	9	Materials and methods - data collection and statistical analysis
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	9	Materials and methods - data collection and statistical analysis
Bias	9	Describe any efforts to address potential sources of bias		
Study size	10	Explain how the study size was arrived at	6	Materials and methods-study design, setting and study population

Continued on next page

Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why		
Statistical methods	12	(a) Describe all statistical methods, including those used to control for confounding	9	Materials and methods - data collection and statistical analysis
		(b) Describe any methods used to examine subgroups and interactions		
		(c) Explain how missing data were addressed		
		(d) <i>Cohort study</i> —If applicable, explain how loss to follow-up was addressed <i>Case-control study</i> —If applicable, explain how matching of cases and controls was addressed <i>Cross-sectional study</i> —If applicable, describe analytical methods taking account of sampling strategy		
		(e) Describe any sensitivity analyses		
Results				
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	11	results
		(b) Give reasons for non-participation at each stage	11	results
		(c) Consider use of a flow diagram		
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	11	Results-Table1
		(b) Indicate number of participants with missing data for each variable of interest	11	results
		(c) <i>Cohort study</i> —Summarise follow-up time (eg, average and total amount)	11,12	Results-Table 1
Outcome data	15*	<i>Cohort study</i> —Report numbers of outcome events or summary measures over time	11-13	Results-Table 1
		<i>Case-control study</i> —Report numbers in each exposure category, or summary measures of exposure		
		<i>Cross-sectional study</i> —Report numbers of outcome events or summary measures		
Main results	16	(a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	11-18	Results-Table 4
		(b) Report category boundaries when continuous variables were categorized		
		(c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period		

Continued on next page

Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses		
Discussion				
Key results	18	Summarise key results with reference to study objectives	18	discussion
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	22	discussion
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	8-22	discussion
Generalisability	21	Discuss the generalisability (external validity) of the study results	8-22	discussion
Other information				
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	23	funding

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at <http://www.plosmedicine.org/>, Annals of Internal Medicine at <http://www.annals.org/>, and Epidemiology at <http://www.epidem.com/>). Information on the STROBE Initiative is available at www.strobe-statement.org.

BMJ Open

The protocol and clinical characteristics of patients under “at-home care” for coronavirus disease 2019 in South Korea: a retrospective cohort study

Journal:	<i>BMJ Open</i>
Manuscript ID	bmjopen-2022-061765.R2
Article Type:	Original research
Date Submitted by the Author:	13-May-2022
Complete List of Authors:	Park, Jin Ju; Hallym University College of Medicine, Department of Internal Medicine Seo, Yu Bin; Hallym University College of Medicine, Department of Internal Medicine Lee, J; Hallym University College of Medicine, Department of Internal medicine Na, Sun Hee; Hallym University College of Medicine, Department of Internal Medicine Choi, Young Kyun; Chungnam National University College of Medicine, Department of Internal Medicine
Primary Subject Heading:	Infectious diseases
Secondary Subject Heading:	Epidemiology, Public health
Keywords:	COVID-19, PUBLIC HEALTH, INFECTIOUS DISEASES

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4 1 **Title**

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7 2 **The protocol and clinical characteristics of patients under “at-home care” for**
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9 3 **coronavirus disease 2019 in South Korea: a retrospective cohort study**

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12 4 Jin Ju Park,¹ Yu Bin Seo,^{1,*} Jacob Lee,¹ Sun Hee Na,¹ Young Kyun Choi ²

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22 **ABSTRACT**

23 **Objective**

24 As the number of patients with coronavirus disease 2019 (COVID-19) increased, at-home care
25 was introduced for the first time in South Korea. This study aimed to analyze the characteristics
26 and outcomes of patients who were treated under at-home care.

27 **Design, setting, and participants**

28 This retrospective cohort study targeted patients under at-home care for COVID-19 in
29 Yeoungdeungpo-gu in Seoul, Korea, from October 18, 2021 to December 12, 2021. The public
30 health center selected eligible patients for at-home care and registered with our institution.
31 Nurses monitored patients, and doctors decided to transfer healthcare facilities and release the
32 quarantined patients according to their symptoms.

33 **Outcome Measures:** Patient characteristics during the course of at-home care

34 **Results**

35 A total of 1,422 patients were enrolled and 9,579 patient days were managed. Most patients
36 were aged ≥ 60 years (22.7% [n=323]), and 82.8% did not have underlying conditions. The
37 median length of care for patients was 8 days (interquartile range: 5–10 days). During the study
38 period, 986 (69.3%) patients were released from quarantine, 82 (5.8%) patients were
39 transferred to facilities, and 354 (24.9%) patients were still under at-home care at the end of
40 the study period. The most common cause of transfer was sustained fever (n = 30, 36.6%),
41 followed by dyspnea and desaturation (n = 17, 20.7%). Factors associated with transfer were
42 diabetes (odds ratio [OR]: 3.591, 95% confidence interval [CI]: 1.488–8.665, $P = 0.004$),
43 pregnancy (OR: 5.839, 95% CI: 1.035–32.935, $P = 0.046$), and being pre-symptomatic at

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4 44 diagnosis (OR: 4.015, 95% CI: 1.559–10.337, $P = 0.004$).
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7 45 **Conclusions**
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10 46 There were no specific problems related to patient safety when operating at-home care. Patients
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12 47 with risk factors, such as diabetes, were more likely to be transferred to healthcare facilities.
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15 48 For safe at-home care, it is necessary to prepare for an appropriate response to the emergency.
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21 50 **Keywords:** COVID-19; home care; protocol; outcome
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26 52 **Strengths and limitations of this study:**
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- 29 53 • This was the first study to introduce at-home care protocol for patients with
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31 54 COVID-19.
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34 55 • This was a single-center retrospective cohort study.
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37 56 • This study depicted the early phase of at-home care for patients with COVID-
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58 INTRODUCTION

59 Severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) was first discovered in
60 Wuhan, China, in December 2019, and since the World Health Organization announced the
61 pandemic in March 2020, there have been approximately 290 million confirmed cases of
62 coronavirus disease 2019 (COVID-19) worldwide, as of December 2021.[1,2] With the
63 development of vaccines, the number of confirmed cases in the United States and Europe
64 seemed to be decreasing, but due to the easing of quarantine measures and the presentation of
65 new variants, the number of confirmed cases skyrocketed again. There was no difference in the
66 domestic situation. With the start of vaccination, the overall quarantine level was relieved.
67 However, subsequently, a fourth epidemic occurred in Korea. In addition, emerging new
68 variants have led to the updating of new confirmed cases daily.[3]

69 During each epidemic situation, the medical system faced a crisis, and it was accompanied by
70 difficulties in allocating medical personnel, supplies, and beds. During the initial epidemic,
71 community treatment centers (CTC) for asymptomatic or mild patients were operated to fill
72 the medical gap in Korea.[4–6] As the epidemic progressed, it became difficult to cope with
73 the increasing number of patients with COVID-19 with CTCs alone. The occurrence of
74 pediatric and psychological problems was another challenge for the CTC setting.[7,8]

75 As the COVID-19 pandemic protracted, the Korean government modified its policy for the
76 management of critically ill patients with COVID-19. The domestic metropolitan area
77 introduced at-home care as an alternative to a deficient medical system. This is the first home
78 healthcare system for the management and monitoring of patients suffering from infectious
79 diseases in Korea. To overcome the current COVID-19 pandemic and prepare for a novel
80 infectious disease, a well-established at-home care system is required. In this study, we aimed

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4 81 to introduce an at-home care protocol that is being implemented through our institution and
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6 82 analyze the characteristics and outcomes of patients under at-home care during the COVID-19
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9 83 pandemic.

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15 85 **MATERIALS AND METHODS**

18 86 **Study design, setting, and study population**

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21 87 This was a retrospective cohort study that used medical records. Kangnam Sacred Heart
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23 88 Hospital is a secondary university hospital with 572 beds located in Yeongdeungpo-gu, Seoul,
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25 89 South Korea. This institution provides internal medicine, surgery, and pediatric intensive care
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28 90 units, as well as an emergency center and outpatient department. This institution is responsible
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30 91 for treating patients mainly in the local constituency. Our institution signed an agreement with
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32 92 Yeongdeungpo-gu administration to become a provider of at-home medical care on October 5,
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34 93 2021 and started operating as such on October 18, 2021. All patients under at-home care via
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37 94 Kangnam Sacred Heart Hospital between October 18, 2021 and December 12, 2021, were
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39 95 included in this study.

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45 97 **Criteria for patient enrollment and release from quarantine**

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48 98 In Korea, COVID-19 was designated as a Class 1 legal infectious disease, which required all
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50 99 confirmed patients to report to public health authorities and to be quarantined for a set period.
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53 100 The person in charge of the public health center interviewed all patients with confirmed
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55 101 diagnoses of COVID-19 and determined whether at-home care was appropriate or if they
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57 102 required hospital admission. Patients who could be treated at home and who provided consent

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4 103 to public health center were registered at our institution as at-home care patients.
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7 104 On November 26, 2021, policies for the care of patients with COVID-19 were changed, as
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9 105 were the criteria for at-home care. Before this date, asymptomatic confirmed COVID-19
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11 106 patients and those with mild symptoms under 70 years of age with no risk of hospitalization
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14 107 were eligible to receive at-home care. From November 26, 2021, onward, all patients were
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16 108 eligible to receive at-home care and were admitted to healthcare facilities only if there was a
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19 109 need for hospitalization.
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21 110 **Enrollment criteria**

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24 111 Before November 26, 2021, the Korea Centers for Disease Control and Prevention classified
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26 112 patients with asymptomatic and mild symptoms under 70 years of age as candidates for at-
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28 113 home care, following consent, except in the presence of the following risk factors for
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30 114 hospitalization: mental change after symptom onset of COVID-19, dyspnea, uncontrolled fever
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32 115 with antipyretics, uncontrolled diabetes mellitus (DM), hemodialysis, patients treated for
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34 116 chronic lung disease, asthma, heart failure, coronary artery disease, patients under
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36 117 chemotherapy or immunosuppressant, uncontrolled symptomatic psychiatric disease,
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38 118 bedridden states, obese (body mass index >30 kg/m²), pregnant women with symptoms, such
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40 119 as abdominal pain, labor, vaginal bleeding, childhood or with a high risk of dyspnea, cyanosis,
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42 120 chest depression, poor oral intake, or dehydration, diagnosed with chronic lung disease/cardiac
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44 121 disease/metabolic disease/abnormal immune system, under immunosuppressant, respiratory
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46 122 function or excretion problem, or risk of aspiration. Among patients over 60 years of age, only
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48 123 those who had been vaccinated were registered for at-home care. Patients in need of care, such
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50 124 as minors and those with disabilities, were required to be accompanied by a caregiver.[9] The
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55 125 exclusion criteria were as follows: 1) those who lived in a residential environment vulnerable
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4 126 to infection due to difficulty in distancing or 2) when communication for non-face-to-face
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6 127 healthcare and quarantine management was difficult for the patient or caregiver.
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9 128 From November 26, 2021, patients with a confirmed COVID-19 diagnosis were all allocated
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11 129 to at-home care, except in the following cases: 1) those who had the aforementioned risk factors
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13 130 for hospitalization, 2) those who lived in a residential environment vulnerable to infection, 3)
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15 131 individuals that were minors, disabled, or over the age of 70 years who required care but could
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17 132 not be quarantined together with a caregiver, 4) those who were deemed ineligible for at-home
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19 133 care treatment by the local government head (e.g., due to a legal problem, etc.).[10]
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23 24 134 **Criteria for release from quarantine**

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27 135 Symptomatic patients were released from quarantine 10 days after symptom onset.[9]
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29 136 Asymptomatic patients were released from quarantine 10 days after diagnosis. The quarantine
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31 137 date was extended depending on the occurrence of symptoms, and the final decision for release
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33 138 was made by the medical staff.
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38 39 40 140 **Intervention**

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43 141 Kangnam Sacred Heart Hospital operated at-home care by targeting patients with COVID-19
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45 142 residing in Yeongdeungpo-gu. The at-home care program involved four medical doctors and
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47 143 five nurses in one monitoring room. They operated during the day and used an on-call system
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49 144 at night. One doctor was in-charge per day, but a backup doctor was designated in case of an
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51 145 emergency. Nurses worked in two shifts, with two nurses during the daytime and evening and
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53 146 one during the night for the on-call system.
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57 147 The Yeondeungpo-gu public health center classified patients with COVID-19 for at-home care
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4 148 according to the enrollment criteria and supplied items necessary for at-home care, such as
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6 149 antipyretics, an oxygen saturation monitor, a thermometer, and phone numbers of related
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9 150 medical institutions. The patients to be managed were registered as outpatients with assigned
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11 151 doctors every day so that prescriptions were available if needed. The list of patients under at-
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13 152 home care was secured through the public health center and updated daily.

16 153 The monitoring room was equipped with computers, monitors, and smartphones. Patients
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18 154 checked their blood pressure and body temperature and uploaded the data via smartphone
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20 155 applications. Nurses called the patient at 9 a.m. and 5 p.m. daily to check the patient's vital
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22 156 signs and symptoms and update patient information on electronic health records. If the patient
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24 157 had symptoms and wanted to take medication, the doctor interviewed the patient and prescribed
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26 158 the medicine. The prescription was sent to the public health center by fax. After prescribing
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28 159 the medicine at the pharmacy, the person in charge of the public health center delivered the
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30 160 medicine to the patient's house. If the patient had persistent fever, desaturation, or worsening
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32 161 clinical symptoms, the doctor interviewed the patient and decided whether to transfer the
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34 162 patient to another facility at the discretion of that doctor, such as a CTC or hospital, according
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36 163 to severity. The public health center assigned an ambulance and medical institution and
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38 164 transported the patient accordingly.

44 165 The medical staff checked the list of patients who were subject to release from quarantine daily
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46 166 and assessed whether it was possible to release them from quarantine according to the criteria.
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48 167 When those under quarantine were released, at-home care and monitoring also ended. The
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50 168 results were then reported to the public health center.

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57 170 **Data collection and statistical analysis**

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4 171 Data regarding patient characteristics, such as age, sex, enrollment date, release from
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6 172 quarantine date, transfer date (if transferred), symptoms, and medical prescription, were
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9 173 collected through a retrospective medical record review.

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12 174 Continuous variables are presented as mean \pm standard deviation (SD) or median (interquartile
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14 175 range [IQR]), as appropriate. Statistical significance was assessed using the chi-squared test
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16 176 and Fisher's exact test for categorical variables. Non-categorical variables were tested using
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18 177 the two-sided unpaired t-test or Mann-Whitney U test. The factors associated with transfer
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21 178 were calculated using a logistic regression model. Statistical significance was set at $P < 0.05$.

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23 179 All statistical analyses were performed using SPSS ver. 27 (IBM, Armonk, NY).

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27 28 29 181 **Patient and public involvement**

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32 182 None.

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36 37 184 **RESULTS**

38 39 40 185 **Baseline characteristics of study population**

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43 186 During the study period, 1,453 patients were registered. Three patients moved to another
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45 187 district, and twenty-eight patients were excluded from at-home care on the day of admission
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47 188 due to other causes of admission, such as severe symptoms at diagnosis. Finally, a total of
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50 189 1,422 patients and 9,574 patient days were managed under at-home care at Kangnam Sacred
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52 190 Heart Hospital. The number of patients managed daily is shown in Figure 1.

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55 191 Among 1,422 patients, 725 (51.0%) were male, and the median age was 40 (IQR: 27–58, range:
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57 192 0–87) years (Table 1). Most patients were over 60 years of age (22.7% [n = 323]), followed by

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4 193 those in their 30s (18.5% [n = 263]). Further, most patients (n = 1,177; 82.8%) did not have
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6 194 underlying conditions, and hypertension (n = 153; 10.8%) was the most common comorbidity.
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9 195 Approximately 16.4% (n = 233) of patients under at-home care were asymptomatic. There were
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11 196 209 cases of drug prescriptions in 176 (12.4%) patients. On average, 3.7 ± 3.73 (range: 0–16)
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13 197 prescriptions were requested per day. Symptoms for the prescribed drugs are described in Table
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16 198 2. The most common symptom was cough (n = 115; 55.8%), followed by sputum production
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18 199 (n = 62; 30.1%) and sore throat (n = 54; 26.2%). Night calls occurred in 68 cases which was
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20 200 an average of 1.2 ± 1.64 (range: 0–6 cases) night calls per day.
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202 **Table 1. Baseline characteristics of patients under at-home care system (n = 1422)**

Characteristics	Total (N = 1422) N (%)	Released from quarantine (N = 986) N (%)	Transferred (N = 82) N (%)	<i>P</i> -value
Sex				0.873
Male	725 (51.0)	508 (51.5)	43 (52.4)	
Female	697 (49.0)	478 (48.5)	39 (47.6)	
Mean age, years (range)	40 (0–87)	40 (0–83)	45 (1–87)	0.051
0–9	156 (11.0)	109 (11.1)	3 (3.7)	
10–19	122 (8.6)	73 (7.4)	10 (12.2)	
20–29	151 (10.6)	112 (11.4)	8 (9.8)	
30–39	263 (18.5)	194 (19.7)	14 (17.1)	

40–49	186 (13.1)	120 (12.2)	11 (13.4)	
50–59	221(15.5)	152 (15.4)	11 (13.4)	
≥60	323 (22.7)	225 (22.9)	25 (30.5)	
Underlying conditions				
Hypertension	153 (10.8)	99 (10.0)	15 (18.3)	0.020
Diabetes	43 (3.0)	28 (2.8)	7 (8.5)	0.005
Thyroid disease	22 (1.5)	17 (1.7)	0 (0)	0.231
Psychiatric disorder	12 (0.8)	10 (1.0)	1 (1.2)	0.860
Pregnancy	6 (0.4)	4 (0.4)	2 (2.4)	0.018
Others*	53 (3.7)	26 (2.6)	5 (6.1)	
None	1177 (82.8)	820 (83.2)	60 (73.2)	0.022
Symptoms				0.009
Asymptomatic	233 (16.4)	159 (16.1)	7 (8.5)	
Pre-symptomatic	160 (11.3)	89 (9.0)	15 (18.3)	
Symptomatic	1029 (72.4)	738 (74.8)	60 (73.2)	
Medicine prescription	176 (12.4)	117 (11.9)	21 (25.6)	0.020
Transfer to healthcare facilities	82 (5.8)			
Cumulative percentage of duration from symptom onset to transfer (%)				
3 days			18.3	

5 days					54.9	
7 days					74.4	
10 days					95.1	
14 days					100	
Median days from symptoms to diagnosis, days (IQR)	2 (1–4)	2 (1–4)	2 (1–3.75)	0.307		
Median days from diagnosis to management, days (IQR)	1 (0–1)	1 (0–2)	0 (0–1)	< 0.001		
Median management days ** , days (IQR)	8 (5–10)	8 (6–10)	3 (2–4.25)	< 0.001		

203 IQR: interquartile range

204 * Epilepsy, autoimmune disease, liver disease, asthma, bronchiectasis, angina, cerebrovascular
205 disease, ulcerative colitis

206 ** Release from quarantine and transferred patients, excluded under management

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208 **Table 2. Symptoms for prescription medication (n = 209)**

Symptoms*	No. (%)
Cough	115 (55.8)

Sputum production	62 (30.1)
Sore throat	54 (26.2)
Nasal congestion	38 (18.4)
Rhinorrhea	33 (16.0)
Fever	17 (8.3)
Headache	14 (6.8)
Myalgia	8 (3.9)
Conjunctivitis	7 (3.4)
Gastrointestinal symptoms	7 (3.4)
Other**	10 (4.9)

209 * Allowed duplicates

210 ** Sleep disorder, febrile sense, underlying disease

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212 The median length from symptoms to diagnosis was 2 days (IQR: 1–4 days), and 1 day (IQR:
 213 0–1 day) from diagnosis to management. The median length of care for patients was 8 days
 214 (IQR: 5–10 days). During the study period, 986 (69.3%) patients were released from quarantine,
 215 82 (5.8%) patients were transferred to CTCs or hospitals, and 354 (24.9%) patients were still
 216 under at-home care when the study period ended. No patients under at-home care died during
 217 the study period.

218 **Characteristics according to transfer**

219 A total of 83 (5.8%) patients were transferred. Sex and age did not differ significantly according
 220 to the transfer (Table 1). Among the transferred patients, 52.4% (n = 43) were male, and

221 patients over 60 years of age ($n = 25$; 30.5%) were most frequently transferred. Patients with
 222 comorbidities were significantly more likely to be transferred than those who were released
 223 from quarantine (25.8% vs. 16.8%, $P = 0.022$). The proportion of patients with hypertension
 224 and DM was significantly higher among transferred patients (10.0% vs. 18.3%, $P = 0.020$,
 225 2.8% vs. 8.5%, $P = 0.005$). The proportion of pregnant women was significantly higher among
 226 transferred patients (0.4% vs. 2.4%, $P = 0.018$). The median management duration of at-home
 227 care was 8 days (IQR: 6–10 days) for release from quarantine and 3 days (IQR: 2–4.25 days)
 228 for transferred patients.

229 The most common cause of transfer was sustained fever ($n = 30$; 36.6%) (Table 3). Seventeen
 230 patients (20.7%) were transferred because of dyspnea, and their oxygen saturation was $<90\%$.
 231 The time from symptom onset to transfer request was a median 5 days (IQR: 4–8 days), and a
 232 median 3 days (IQR: 2–5 days) were required from diagnosis to transfer request. Most transfers
 233 ($n = 61$; 75.5%) were made on the same day as the transfer requests. For 21 (25.6%) patients,
 234 it took 1 day to allocate a bed after the request. One patient required 2 days and one patient
 235 required 3 days for transfer. All patients with dyspnea were transferred on the same day.

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237 **Table 3. Reasons for transfer (n = 82)**

Reasons	No. (%)
Sustained fever	30 (36.6)
Dyspnea/desaturation	17 (20.7)
Patients wanted	13 (15.9)
Cough/chest pain	9 (11.0)

Resident with family	5 (6.1)
Minor	4 (4.9)
Aggravation of underlying disease	2 (2.4)
As caregiver	1 (1.2)
Old age	1 (1.2)

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239 Risk factors for transfer

240 The factors associated with transfer are shown in Table 4. In univariate analysis, age and sex
 241 were not significantly associated with transfer. The presence of underlying disease (odds ratio
 242 [OR]: 1.811, 95% confidence interval [CI]: 1.081–3.035, $P = 0.024$), hypertension (OR: 2.006,
 243 95% CI: 1.104–3.644, $P = 0.022$), DM (OR: 3.193, 95% CI: 1.350–7.553, $P = 0.008$), and
 244 pregnancy (OR: 6.137, 95% CI: 1.107–34.023, $P = 0.038$) were significantly associated with
 245 transfer. On multivariate analysis, we found no significant association of age or sex with
 246 transfer. DM (OR: 3.591, 95% CI: 1.488–8.665, $P = 0.004$), pregnancy (OR: 5.839, 95% CI:
 247 1.035–32.935, $P = 0.046$), and being pre-symptomatic (OR: 4.015, 95% CI: 1.559–10.337, P
 248 = 0.004) were independent risk factors for transfer.

249 **Table 4. Factors associated with transfer**

Variables	Univariate analysis			Multivariate analysis		
	OR	95% CI	P -value	OR	95% CI	P -value
Female sex	0.964	0.614–1.513	0.873	0.742	0.579–1.476	0.742
Age						
0–9 years	0.385	0.100–1.491	0.167	0.439	0.112–1.723	0.238

10–19 years	1.918	0.723–5.086	0.191	2.169	0.804–5.849	0.126
20–29 years	reference		reference	reference		reference
30–39 years	0.982	0.411–2.483	0.982	0.957	0.384–2.386	0.924
40–49 years	0.605	0.498–3.306	0.605	1.371	0.523–3.596	0.521
50–59 years	0.978	0.395–2.601	0.978	0.961	0.360–2.566	0.937
>60 years	0.300	0.677–3.544	0.300	1.346	0.547–3.315	0.518
Underlying disease	1.811	1.081–3.035	0.024	0.662	0.219–1.999	0.465
Hypertension	2.006	1.104–3.644	0.022	2.106	0.682–10.20	0.196
Diabetes mellitus	3.193	1.350–7.553	0.008	3.591	1.488–8.665	0.004
Pregnancy	6.137	1.107–34.02	0.038	5.839	1.035–32.93	0.046
Symptoms		3			5	
Asymptomatic	reference		reference	reference		reference
Pre-symptomatic	3.828	1.505–9.741	0.005	4.015	1.559–10.33	0.004
Symptomatic	1.847	0.829–4.115	0.134	1.983	0.880–4.469	0.099

250 OR: odds ratio, CI: confidence interval

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252 DISCUSSION

253 Despite the increase in vaccination against COVID-19, the number of confirmed cases
 254 worldwide has been increasing due to the easing of quarantine measures, waning vaccination

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4 255 immunity, and the emergence of new SARS-CoV-2 variants.[1] Because of the limitations of
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6 256 medical manpower and resources, such as hospital beds, at-home care was introduced in Korea.
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9 257 As this system was introduced for the first time in Korea, we aimed to explain the initial
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11 258 operating protocol and results.
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14 259 In Korea, since the first COVID-19 outbreak in Daegu in 2020, CTCs have been operating in
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16 260 the face of the COVID-19 epidemic. Some facilities, such as dormitories and hotels, were
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18 261 converted to quarantine units for patients with COVID-19, and a monitoring system for patients
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20 262 with stationed medical staff was established. This system was flexibly operated according to
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22 263 trends in the number of confirmed cases. To operate a CTC, it is necessary to provide a space
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24 264 for both quarantining patients and working medical staff. To prepare such facilities, a certain
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26 265 period was required, and after the increase in the number of confirmed cases, there were
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28 266 difficulties in arranging space and medical staff. This could be managed in the case of a short-
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30 267 term epidemic, but as the epidemic became longer and the number of confirmed cases increased,
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32 268 like during the fourth epidemic in Korea, there was a limit to the management through CTCs.
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35 269 The medical system was saturated due to the number of confirmed cases and the increase in
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37 270 the number of patients with severe cases; therefore, the government of the Republic of Korea
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39 271 changed the policy for the management of severely ill patients. As a result, at-home care was
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41 272 introduced in Korea. Before the fourth epidemic, some local governments operated at-home
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43 273 care by a public health center for certain patients, such as children and their parents, or patients
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45 274 who were healthy and young. As the fourth epidemic began, at-home care expanded its target
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47 275 to all over the country and was managed by hospitals from October 2021.
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54 276 With the COVID-19 pandemic, some countries, including the United States, quarantined
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56 277 asymptomatic or mild patients in their homes without hospitalization.[11–14] At-home care in
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4 278 Korea was a system that monitored patients twice a day over the phone. Procurement of
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6 279 necessary supplies and transfer systems were established and managed. Through this system,
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9 280 some solutions have been suggested for medical problems that could be missed due to simple
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11 281 home quarantine alone.

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14 282 Entering quarantine facilities, such as a CTC, due to COVID-19 could cause psychological
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16 283 problems. Approximately 30% of patients admitted to a CTC complained of psychological
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18 284 problems due to quarantine in an unfamiliar environment.[8] In particular, when considering
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20 285 psychological factors and diagnosis time after symptom onset in pediatric patients, which might
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22 286 be after the transmission period had passed, quarantine in a CTC or hospital was somewhat
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24 287 disadvantageous.[7] At-home care compensated for the psychological disadvantages of CTCs
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26 288 by maintaining quarantine in a familiar environment, especially with family.

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32 289 Respiratory symptoms, such as cough, sputum production, sore throat, fever, and anosmia,
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34 290 were symptoms of COVID-19.[4,5,15] In the present study, cough was the most common
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36 291 symptom for which medicines were prescribed. Most prescribed medicines were for respiratory
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38 292 symptoms, but there were also cases of digestive symptoms, conjunctivitis, or sleep disorder.
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41 293 As the COVID-19 epidemic persisted and many patients were treated under at-home care,
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43 294 strategic preparedness was required so that medicines for respiratory symptoms and other
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45 295 possible symptoms could be smoothly supplied to patients. In some cases, patients ran out of
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47 296 medications that were being taken in cases of underlying conditions. This indicated that, during
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49 297 the quarantine period, there may be a need for an alternative to the prescription of medicines
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51 298 for underlying conditions, such as hypertension.

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56 299 Elderly patients and pregnant women have a high risk of acute exacerbation and severity.[16–
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4 300 18] Comorbidities, such as hypertension and DM, were other risk factors for disease
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6 301 aggravation in patients with COVID-19.[18] In the present study, DM and pregnancy were risk
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8 302 factors for transfer, along with pre-symptomatic status. Although age was not significantly
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10 303 associated with transfer, 30.5% of transferred patients were older than 60 years. At-home care
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12 304 patients with underlying conditions or old age required more thorough management with
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14 305 caution.
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19 306 In the present study, 5.8% of patients were transferred to CTCs or hospitals. In a previous study
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21 307 of CTCs that treated asymptomatic or mild COVID-19 patients, the transfer rate ranged from
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23 308 0.7–10.3%.[4,6,19,20] Patients transferred for worsening of symptoms requested a transfer at
24
25 309 a median of 5 days after symptom onset and a median of 3 days from diagnosis. The duration
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27 310 from diagnosis to transfer was different on comparison with a previous study reporting a
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29 311 median of 3.5–11 days.[4,6,15,19] This duration was shorter in the present study because all
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31 312 patients with COVID-19 were under at-home care as a basic treatment, and the proportion of
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33 313 patients who wished to be transferred to a CTC or hospital and that of patients who faced
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35 314 difficulties in self-quarantine was as high as 15.9% and 6.1%, respectively. Patients were
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37 315 transferred quickly after diagnosis. In approximately 55% of cases in this study, transfer
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39 316 requests were made within 5 days of symptom onset. However, in the remaining 45%,
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41 317 symptoms worsened 6 days after symptom onset. Some studies reported that symptoms were
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43 318 aggravated between 4 and 14 days after symptom onset.[21,22] As COVID-19 epidemic
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45 319 prolonged, the monitoring period of at-home care was changed from 10 days to 7 days, and the
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47 320 remaining 3 days were either monitored or not depending on symptoms. Patients with risk
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49 321 factors were monitored thoroughly, as there were some patients who needed to be transferred
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51 322 to a CTC or hospital even at the end of monitoring.
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4 323 This system was not a monitoring and treatment system that checks a patient in real time. The
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6 324 worsening of symptoms may have been missed. This risk was even greater in patients who
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9 325 received at-home care alone. In addition, if the patient did not feel any symptoms even when
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11 326 the condition worsened, the patient might have been left unattended. Difficulty in responding
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13 327 to emergent situations was another problem. Since the patient was not treated in the same space
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16 328 as medical personnel, it took time to directly contact the medical personnel, even if the
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18 329 symptoms were monitored. In addition, after confirming the transfer, it took time to assign and
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20 330 implement emergency measures. Unlike in a CTC, if a transfer was delayed, proper medical
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22 331 measures, such as oxygen supply, were also delayed, which could prove to be fatal to patients.
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25 332 Therefore, there is a need for a system that secures and utilizes an ambulance and an available
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27 333 emergency bed for at-home care patients in advance.

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31 334 Currently, in a situation where the number of patients with COVID-19 has skyrocketed and the
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33 335 basic treatment policy has been switched to at-home care, the number of patients receiving at-
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35 336 home care is continuously increasing. Because at-home care was a system in which medical
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37 337 staff directly interviewed patients twice a day over the phone, medical personnel were needed
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40 338 for this. Administrative personnel were also required to allocate patients, deliver supplies, and
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42 339 deliver drugs through prescriptions. In the beginning of the COVID-19 epidemic, patient
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44 340 management with the help of assigned medical personnel was possible, but as the number of
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46 341 patients increased, management by the existing staff became difficult. This may lead to future
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48 342 difficulties in identifying patients and responding to patients. In preparing for the continuing
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50 343 epidemic, measures should be taken on how to procure the required manpower.

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54 344 This study had some limitations. First, this was a single-center study. As at-home care has been
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56 345 expanded to cover the entire nation and all patients confirmed to have COVID-19, it is

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4 346 necessary to analyze additional data of the results of at-home care. Second, this study analyzed
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6 347 the results of the early phase of at-home care, which was a point in time when the setting was
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9 348 not completely established. Thus, additional system supplementation is required.
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13 14 15 350 **CONCLUSION**

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18 351 Due to the increase in the number of confirmed cases beyond those that medical facilities could
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20 352 handle, at-home care was an unavoidable option. Patients with risk factors, such as DM, were
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22 353 more likely to be transferred to healthcare facilities. For safe at-home care, it is necessary to
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24 354 prepare for an appropriate response to the emergency.
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4 356 **Acknowledgments**
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10 358 **Contributors**
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13 359 YBS conceptualized and edited the manuscript. JJP contributed to data curation, data analysis,
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15 360 and manuscript writing. JL, SHN, and YKC contributed to acquisition of data. All authors have
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17 361 read and approved the submission.
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20 362 **Funding**
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23 363 This study was supported by the Korea National Research Foundation (NRF) grant funded by
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25 364 the Korean government (MEST) (NRF-2021M3E5E308120711)
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29 365 **Competing interests**
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32 366 None declared.
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35 367 **Ethics approval**
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38 368 The study was approved by the Institutional Review Board (IRB) of Kangnam Sacred Heart
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40 369 Hospital (IRB No.: 2021-11-035-001), and the requirement for informed consent was waived.
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43 370 **Data availability statement**
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46 371 No data available.
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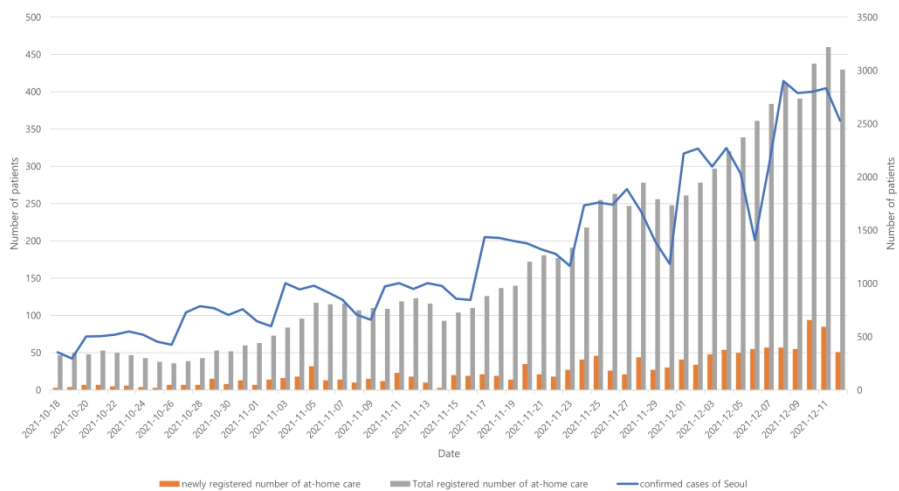
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444 **Figure legend**

445 Figure 1. Trends of number of patients with COVID-19 in this study and in Seoul, South Korea

For peer review only



Trends of number of patients with COVID-19 in this study and in Seoul, South Korea

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STROBE Statement—checklist of items that should be included in reports of observational studies

	Item No.	Recommendation	Page No.	Relevant text from manuscript
Title and abstract	1	(a) Indicate the study's design with a commonly used term in the title or the abstract	2	Retrospective cohort study
		(b) Provide in the abstract an informative and balanced summary of what was done and what was found	2, 3	abstract
Introduction				
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	4	introduction
Objectives	3	State specific objectives, including any prespecified hypotheses	4, 5	introduction
Methods				
Study design	4	Present key elements of study design early in the paper	6	Materials and methods-study design, setting and study population
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	6,9	Materials and methods-study design, setting and study population Materials and methods - data collection and statistical analysis
Participants	6	(a) <i>Cohort study</i> —Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up <i>Case-control study</i> —Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls <i>Cross-sectional study</i> —Give the eligibility criteria, and the sources and methods of selection of participants	7, 8	Materials and methods - criteria for enrolment and and release from quarantine
		(b) <i>Cohort study</i> —For matched studies, give matching criteria and number of exposed and unexposed <i>Case-control study</i> —For matched studies, give matching criteria and the number of controls per case		

Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	9	Materials and methods - data collection and statistical analysis
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	9	Materials and methods - data collection and statistical analysis
Bias	9	Describe any efforts to address potential sources of bias		
Study size	10	Explain how the study size was arrived at	6	Materials and methods-study design, setting and study population

Continued on next page

Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why		
Statistical methods	12	(a) Describe all statistical methods, including those used to control for confounding	9	Materials and methods - data collection and statistical analysis
		(b) Describe any methods used to examine subgroups and interactions		
		(c) Explain how missing data were addressed		
		(d) <i>Cohort study</i> —If applicable, explain how loss to follow-up was addressed <i>Case-control study</i> —If applicable, explain how matching of cases and controls was addressed <i>Cross-sectional study</i> —If applicable, describe analytical methods taking account of sampling strategy		
		(e) Describe any sensitivity analyses		
Results				
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	11	results
		(b) Give reasons for non-participation at each stage	11	results
		(c) Consider use of a flow diagram		
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	11	Results-Table1
		(b) Indicate number of participants with missing data for each variable of interest	11	results
		(c) <i>Cohort study</i> —Summarise follow-up time (eg, average and total amount)	11,12	Results-Table 1
Outcome data	15*	<i>Cohort study</i> —Report numbers of outcome events or summary measures over time	11-13	Results-Table 1
		<i>Case-control study</i> —Report numbers in each exposure category, or summary measures of exposure		
		<i>Cross-sectional study</i> —Report numbers of outcome events or summary measures		
Main results	16	(a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	11-18	Results-Table 4
		(b) Report category boundaries when continuous variables were categorized		
		(c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period		

Continued on next page

Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses		
Discussion				
Key results	18	Summarise key results with reference to study objectives	18	discussion
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	22	discussion
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	8-22	discussion
Generalisability	21	Discuss the generalisability (external validity) of the study results	8-22	discussion
Other information				
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	23	funding

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at <http://www.plosmedicine.org/>, Annals of Internal Medicine at <http://www.annals.org/>, and Epidemiology at <http://www.epidem.com/>). Information on the STROBE Initiative is available at www.strobe-statement.org.