



# Clinical Features and Outcomes of 98 Patients Hospitalized with SARS-CoV-2 Infection in Daegu, South Korea: A Brief Descriptive Study

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Although some information on the epidemiology of severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) and a few selected cases has been reported, data on the clinical characteristics and outcomes of patients hospitalized therewith in South Korea are lacking. We conducted a retrospective single-center study of 98 consecutive hospitalized patients with confirmed SARS-CoV-2 infection at Yeungnam University Medical Center in Daegu, South Korea. Sixty patients were women (61.2%), and the mean age was 55.4±17.1 years. Thirteen patients (13.3%) were treated in the intensive care unit (ICU). The mean interval from symptom onset to hospitalization was 7.7±4.5 days. Patients who received ICU care were significantly older and were more likely to have diabetes mellitus. The National Early Warning Score on the day of admission was significantly higher in patients requiring ICU care. Acute respiratory distress syndrome (13/13 patients; 100%), septic shock (9/13; 69.2%), acute cardiac injury (9/13; 69.2%), and acute kidney injury (8/13; 61.5%) were more common in patients who received ICU care. All patients received antibiotic therapy, and most (97/98 patients; 99.0%) received antiviral therapy (lopinavir/ritonavir). Hydroxychloroquine was used in 79 patients (80.6%), and glucocorticoid therapy was used in 18 patients (18.4%). In complete blood counts, lymphopenia was the most common finding (40/98 patients; 40.8%). Levels of all proinflammatory cytokines were significantly higher in ICU patients. As of March 29, 2020, the mortality rate was 5.1%. Here, we report the clinical characteristics and laboratory findings of SARS-CoV-2 patients in South Korea up to March 29, 2020.

**Key Words:** Coronavirus, SARS-CoV-2, COVID-19, Korea, clinical characteristics

In December 2019, a severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) pandemic causing pneumonia began in Wuhan, China. By March 29, 2020, 9583 cases of coronavi-

rus disease 2019 (COVID-19) had been diagnosed in South Korea. Although several Chinese studies have described the clinical characteristics of COVID-19,<sup>1-3</sup> there are no such studies for Korea. As patient-, disease-, physician-, and healthcare system-related factors can be associated with mortality from COVID-19, we sought to describe the clinical and radiological characteristics of SARS-CoV-2 patients admitted to Yeungnam University Medical Center in Daegu, South Korea up to March 29, 2020, as well as laboratory findings.

This study was conducted in accordance with the tenets of the Declaration of Helsinki, and was reviewed and approved by the Institutional Review Board of Yeungnam University Hospital (YUH IRB 2020-03-057). The requirement for informed consent was waived because of the retrospective study design. The final date of follow-up was March 29, 2020.

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**Table 1.** Baseline Characteristics and Radiological Findings of Patients Admitted to Yeungnam University Medical Center with SARS-CoV-2 Infection

Characteristics	All patients (n=98)	ICU (n=13)	Non-ICU (n=85)	p value
Age (yr)	55.4±17.1	63.2±10.1	54.2±17.7	0.014
21–49	29 (29.6)	1 (7.7)	28 (32.9)	0.054
50–64	40 (40.8)	6 (46.2)	34 (40.0)	
≥65	29 (29.6)	6 (46.2)	23 (27.1)	
Sex				0.558
Male	38 (38.8)	6 (46.2)	32 (37.6)	
Female	60 (61.2)	7 (53.8)	53 (62.4)	
Interval from symptom onset to hospital admission (day)	7.7±4.5	4.7±3.1	8.2±4.6	0.009
Exposure history				
Shincheonji follower	47 (48.0)	2 (15.4)	45 (52.9)	0.012
Comorbidities	38 (38.8)	5 (38.5)	33 (38.8)	0.980
Cardiovascular disease	11 (11.2)	0 (0)	11 (12.9)	0.350
Cerebrovascular disease	2 (2.0)	0 (0)	2 (2.4)	1.000
Chronic lung disease	3 (3.1)	0 (0)	3 (3.5)	1.000
Dementia	3 (3.1)	0 (0)	3 (3.5)	1.000
Diabetes mellitus	9 (9.2)	3 (23.1)	6 (7.1)	0.096
Hypertension	30 (30.6)	5 (38.5)	25 (29.4)	0.529
Liver disease	1 (1.0)	0 (0)	1 (1.2)	1.000
Malignancy	4 (4.1)	1 (7.7)	3 (3.5)	0.439
Parkinson's disease	1 (1.0)	1 (7.7)	0 (0)	0.133
Symptoms on admission				
Fever	62 (63.3)	8 (61.5)	54 (63.5)	1.000
Cough	58 (59.2)	6 (46.2)	52 (61.2)	0.305
Sputum	39 (39.8)	2 (15.4)	37 (43.5)	0.054
Myalgia	37 (37.8)	3 (23.1)	34 (40.0)	0.359
Dyspnea	32 (32.7)	8 (61.5)	24 (28.2)	0.026
Vital signs on admission				
Body temperature, °C	37.3±0.7	37.5±0.9	37.3±0.7	0.321
Heart rate, beats/min	84.7±16.1	83.5±20.4	84.9±15.5	0.321
Respiratory rate	22.3±9.5	30.0±18.6	21.2±6.7	0.115
Systolic BP, mm Hg	127.9±18.4	135.5±20.3	126.7±18.0	0.109
Diastolic BP, mm Hg	80.2±12.4	84.4±11.6	79.6±12.5	0.199
Mean arterial BP, mm Hg	96.1±12.9	101.4±14.1	84.4±11.6	0.111
NEWS	2.6±3.0	7.8±2.9	1.8±2.2	<0.001
Respiratory rate	0.4±0.8	1.3±1.3	0.2±0.6	0.011
Peripheral oxygen saturation	0.7±1.1	2.5±1.0	0.4±0.8	<0.001
Supplemental oxygen	0.5±0.9	1.8±0.6	0.3±0.7	<0.001
Body temperature	0.1±0.3	0.1±0.3	0.1±0.4	0.530
Systolic BP	0.5±0.9	0.9±1.1	0.4±0.8	0.039
Heart rate	0.3±0.6	0.8±1.0	0.3±0.4	0.055
Level of consciousness	0.1±0.5	0.2±0.8	0.1±0.5	0.509
Radiological findings				0.657
Chest X-ray only	34 (34.7)	6 (46.2)	28 (32.9)	
Chest X-ray and CT	64 (65.3)	7 (53.8)	57 (67.1)	
Unilateral pneumonia	14 (14.3)	1 (7.7)	13 (15.3)	
Bilateral pneumonia	34 (34.7)	8 (61.5)	26 (30.6)	
Multiple ground-glass opacity	42 (42.9)	4 (30.8)	38 (44.7)	

BP, blood pressure; CT, computed tomography; ICU, intensive care unit; NEWS, National Early Warning Score; SARS-CoV-2, severe acute respiratory syndrome coronavirus 2.

Data are presented as a mean±SD or number (percentage).

Patient electronic medical records were reviewed. Clinical data included age, sex, exposure history, comorbidities, symptoms, vital signs, radiologic findings, complications, treatment, clinical outcomes, and laboratory findings. Blood samples of some suspected cases were collected for proinflammatory cytokine analysis. The concentrations of cytokines in COVID-19 were determined using commercial enzyme-linked immunosorbent assays.

The National Early Warning Score (NEWS) is an early warning score facilitating the early detection of and responses to patient deterioration.<sup>4</sup> NEWS encompasses seven physiological parameters: pulse oximetry, oxygen, pulse, systolic blood pressure, respiration rate, temperature, and central nervous system status. Each parameter is assigned a score of 0 to 3 points. The score reflects the extent to which the parameter differs from the standard.

Acute respiratory distress syndrome (ARDS) was defined according to the Berlin definition.<sup>5</sup> Septic shock was defined according to the third international consensus definitions for sepsis and septic shock (Sepsis-3).<sup>6</sup> Acute cardiac injury was defined as a serum troponin I level above the 99th percentile upper reference limit or new abnormal electrocardiography and echocardiography findings.<sup>2</sup> Acute kidney injury was defined according to the Kidney Disease Improving Global Guidelines (KDIGO) for acute kidney injury.<sup>7</sup>

The Acute Physiology and Chronic Health Evaluation II (APACHE II), a severity of disease classification system,<sup>8</sup> is widely used as an index of illness severity and as a predictor of outcomes.<sup>9</sup> APACHE II score is based on age, previous health status, and the initial values of 12 physiological measurements. The Sequential Organ Failure Assessment (SOFA) scale is a scoring system designed to evaluate complications in critically ill patients.<sup>10</sup> The SOFA scale assigns a score of 0 to 4 to each of six parameters related to organ function (respiration, coagulation, liver, cardiovascular, central nervous system, and renal).

Continuous variables are expressed as mean±standard deviations (SDs) and were compared using Student's t-test or the Mann-Whitney U test. Categorical variables were compared using the chisquared test or Fisher's exact test. In all analyses, a two-tailed *p* value<0.05 was considered to indicate statistical significance. All statistical analyses were performed using SPSS software (ver. 24.0; IBM Corp., Armonk, NY, USA).

Table 1 shows the baseline clinical characteristics and radiological findings of patients hospitalized with SARS-CoV-2 infection. This study included 98 patients with SARS-CoV-2, 13 (13.3%) of whom were treated in the intensive care unit (ICU). Sixty patients were women (61.2%) and their mean age was 55.4±17.1 years, similar to recently released national epidemiological data for Korea.<sup>11</sup> The mean interval from symptom onset to hospitalization was 7.7 days. Similar to the national epidemiological data,<sup>11</sup> the largest group in our study with a history of exposure was the Shincheonji religious group, which comprised 47 patients (48.0%). In our study, the proportion of pa-

tients over 50 years of age was 70.4%, compared to 44% in China. The large proportion of women over 50 years of age in our research is thought to be related to the outbreak in the Shincheonji religious group whose followers comprise a female majority.

More than one comorbidity was present in 38 patients (38.8%), of whom 30 (30.6%) had hypertension; this was the most prevalent comorbidity. A recent study in China revealed that patients who required ICU care were more likely to have hypertension, diabetes, cardiovascular disease, and cerebrovascular disease than patients who did not receive ICU care.<sup>2</sup> In our study, diabetes mellitus tended to be more common in ICU patients (23.1% vs. 7.1%, *p*=0.096). It was difficult to detect meaningful differences in comorbidities between patients treated in the ICU and those who were not due to the relatively small number of patients.

On admission, about 60% of the patients had a fever and cough, and one-third had sputum, myalgia, and dyspnea. Interestingly, vital signs recorded on the day of admission did not differ between patients who did and did not require ICU care. NEWS values on the day of admission was significantly higher in patients requiring ICU care (7.8±2.9 vs. 1.8±2.2, *p*<0.001). Of the NEWS parameters, body temperature, heart rate, and level of consciousness were not associated with ICU care. The Roy-

**Table 2.** Complications, Treatment, and Clinical Outcomes of Patients with SARS-CoV-2 Infection

	All patients (n=98)	ICU (n=13)	Non-ICU (n=85)	<i>p</i> value
<b>Complications</b>				
ARDS	18 (18.4)	13 (100)	5 (5.9)	<0.001
Septic shock	9 (9.2)	9 (69.2)	0 (0)	<0.001
Acute cardiac injury	11 (11.2)	9 (69.2)	2 (2.4)	<0.001
Acute kidney injury	9 (9.2)	8 (61.5)	1 (1.2)	<0.001
<b>Treatment</b>				
Oxygen	37 (37.8)	12 (92.3)	25 (29.4)	<0.001
HFNC	12 (12.2)	7 (53.8)	5 (5.9)	<0.001
IMV	11 (11.2)	11 (84.6)	0 (0)	<0.001
CRRT	3 (3.1)	3 (23.1)	0 (0)	0.002
ECMO	4 (4.1)	4 (30.8)	0 (0)	<0.001
Antibiotics	98 (100)	13 (100)	85 (100)	
Lopinavir/ritonavir	97 (99.0)	13 (100)	84 (98.8)	1.000
Hydroxychloroquine	79 (80.6)	13 (100)	66 (77.6)	0.067
Glucocorticoid	18 (18.4)	10 (76.9)	8 (9.4)	<0.001
<b>Clinical outcomes</b>				
Remains in hospital	57 (58.2)	7 (53.8)	50 (58.8)	
Discharged	30 (30.6)	1 (7.7)	29 (34.1)	
Died	5 (5.1)	4 (30.8)	1 (1.2)	
Transferred	6 (6.1)	1 (7.7)	5 (5.9)	

ARDS, acute respiratory distress syndrome; CRRT, continuous renal replacement therapy; ECMO, extracorporeal membrane oxygenation; HFNC, high-flow nasal cannula; ICU, intensive care unit; IMV, invasive mechanical ventilation; SARS-CoV-2, severe acute respiratory syndrome coronavirus 2. Data are presented as a number (percentage).

al College of Physicians recommend the use of NEWS to identify patients at risk of cardiac arrest, unanticipated ICU admission, or death. The area under receiver operating characteristic curves of NEWS for predicting unanticipated ICU admission was 0.857 ([95% confidence interval (CI), 0.847–0.868] in a previous study.<sup>4</sup> Our study demonstrated that NEWS was more useful than initial vital signs in predicting ICU admission in patients with COVID-19.

Table 2 shows the complications, treatment patterns, and clinical outcomes of the patients hospitalized with SARS-CoV-2 infection. As previously reported in a Chinese study,<sup>2</sup> our patients who required ICU care had many complications, such as multiple organ failure. ARDS (18/98 patients; 18.4%),

septic shock (9/98; 9.2%), acute cardiac injury (11/98; 11.2%), and acute kidney injury (9/98; 9.2%) were more frequent in our study than in other Chinese studies.<sup>1-3,12</sup> It is estimated that the severity of disease in the COVID-19 patients enrolled in this study was higher than that of the patients in Chinese studies. The greater disease severity may account for higher rates of use of invasive mechanical ventilation (11.2%), extracorporeal membrane oxygenation (4.1%), and continuous renal replacement therapy (3.1%) than reported in the aforementioned Chinese studies.

All patients received antibiotic therapy, and most (99.0%) received antiviral therapy (lopinavir/ritonavir). Hydroxychloroquine was used in 79 (80.6%) patients. Glucocorticoid therapy

**Table 3.** Laboratory Findings of Patients with SARS-CoV-2 Infection on Admission to Hospital

	All patients (n=98)	ICU (n=13)	Non-ICU (n=85)	p value
Complete blood count				
White blood cell count, $\times 10^9/L$	6.5 $\pm$ 3.4	8.9 $\pm$ 3.3	6.1 $\pm$ 3.2	0.005
Increased	9 (9.2)	4 (30.8)	5 (5.9)	0.003
Decreased	18 (18.4)	0 (0)	18 (21.2)	
Neutrophil count, $\times 10^9/L$	4.6 $\pm$ 3.4	7.7 $\pm$ 3.3	4.1 $\pm$ 3.2	<0.001
Increased	20 (20.4)	9 (69.2)	11 (12.9)	<0.001
Lymphocyte count, $\times 10^9/L$	1.4 $\pm$ 0.7	0.8 $\pm$ 0.3	1.5 $\pm$ 0.7	<0.001
Decreased	40 (40.8)	11 (84.6)	29 (34.1)	0.001
Hemoglobin, g/dL	13.0 $\pm$ 1.6	13.5 $\pm$ 1.7	13.0 $\pm$ 1.6	0.253
Decreased	24 (24.5)	3 (23.1)	21 (24.7)	1.000
Platelets, $\times 10^9/L$	237.3 $\pm$ 104.9	186.7 $\pm$ 64.9	245.0 $\pm$ 107.9	0.061
Increased	4 (4.1)	0 (0)	4 (4.7)	0.188
Decreased	13 (13.3)	3 (23.1)	10 (11.8)	
Blood chemistry				
Albumin, g/dL	3.7 $\pm$ 0.5	3.0 $\pm$ 0.3	3.9 $\pm$ 0.5	<0.001
Decreased	33 (34.4)	12 (92.3)	21 (25.3)	<0.001
Alanine aminotransferase, IU/L	33.9 $\pm$ 42.1	58.8 $\pm$ 93.6	30.1 $\pm$ 26.3	0.294
Increased	19 (19.4)	3 (23.1)	16 (18.8)	0.712
Aspartate aminotransferase, IU/L	45.9 $\pm$ 47.2	100.3 $\pm$ 97.0	37.5 $\pm$ 26.6	0.038
Increased	42 (42.9)	11 (84.6)	31 (36.5)	0.001
Total bilirubin, mg/dL	0.9 $\pm$ 0.4	1.1 $\pm$ 0.6	0.8 $\pm$ 0.4	0.071
Increased	16 (16.3)	4 (30.8)	12 (14.1)	0.218
Blood urea nitrogen, mg/dL	15.3 $\pm$ 9.5	20.0 $\pm$ 11.4	14.6 $\pm$ 9.0	0.057
Increased	12 (12.2)	4 (30.8)	8 (9.4)	0.051
Creatinine, mg/dL	0.9 $\pm$ 0.5	1.0 $\pm$ 0.3	0.8 $\pm$ 0.5	0.467
Increased	29 (29.6)	6 (46.2)	23 (27.1)	0.196
Creatinine phosphokinase, IU/L	105.4 $\pm$ 153.9	131.9 $\pm$ 122.0	100.7 $\pm$ 159.1	0.504
Increased	11 (12.6)	2 (15.4)	9 (12.2)	0.667
Lactate dehydrogenase, IU/L	648.0 $\pm$ 350.7	1272.6 $\pm$ 542.1	555.5 $\pm$ 184.0	<0.001
Increased	47 (50.5)	12 (100)	35 (43.2)	<0.001
Infection biomarkers				
C-reactive protein, mg/dL	6.0 $\pm$ 8.4	17.7 $\pm$ 9.5	4.2 $\pm$ 6.7	<0.001
Increased	61 (67.8)	12 (100)	49 (62.8)	0.008
Procalcitonin, ng/mL	0.5 $\pm$ 2.8	2.7 $\pm$ 7.0	0.2 $\pm$ 1.3	0.248
Increased	6 (6.2)	4 (33.3)	2 (2.4)	0.002

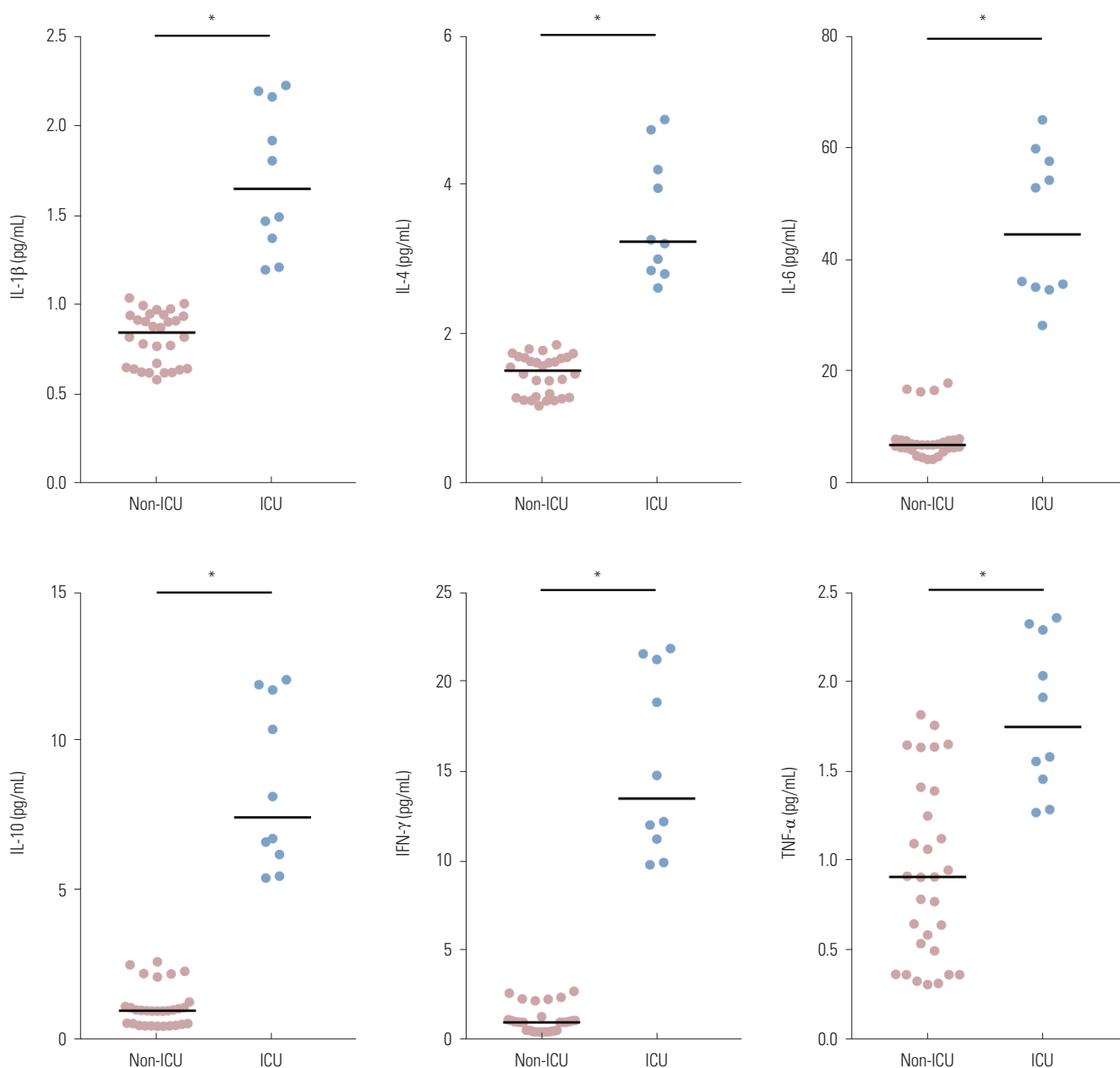
ICU, intensive care unit; SARS-CoV-2, severe acute respiratory syndrome coronavirus 2.

Data are presented as a mean $\pm$ SD or number (percentage).

was used in 18 patients (18.4%); this therapy was used more frequently in patients who required ICU care (76.9% vs. 9.4%,  $p<0.001$ ). According to a study involving 1099 patients in 552 hospitals,<sup>3</sup> 18.6% received systemic glucocorticoids, and 44.5% of patients with severe COVID-19 received systemic glucocorticoids. In our study, 18.4% of all patients received systemic glucocorticoids, and 76.9% of patients in the ICU received systemic glucocorticoids. Because “severity” was not clearly defined in the Chinese study, it is difficult to compare findings. However, the high rate of use of glucocorticoids in our study can be ex-

plained by the fact that 84% of our ICU patients received invasive mechanical ventilation versus just 35.7% of the severe COVID-19 patients in the Chinese study. Wu, et al.<sup>13</sup> reported that treatment with methylprednisolone decreased the risk of death (hazard ratio, 0.38; 95% CI, 0.20–0.72) in patients with COVID-19 pneumonia who developed ARDS. The use of glucocorticoids for COVID-19 is beneficial in certain groups of patients, although further investigation is needed to identify the subgroups that can benefit the most.

As of March 29, 30 patients (30.6%) had been discharged,



**Fig. 1.** Concentrations of proinflammatory cytokines in the plasma of SARS-CoV-2 patients. Plasma levels of the proinflammatory cytokines IL-1 $\beta$ , IL-4, IL-6, IL-10, IFN- $\gamma$ , and TNF- $\alpha$  in SARS-CoV-2-infected non-ICU (n=30) and ICU (n=10) patients. Data are presented as a mean  $\pm$  standard error of the mean. \* $p<0.001$  vs. non-ICU (one-way ANOVA). IL, interleukin; ICU, intensive care unit; IFN, interferon; TNF, tumor necrosis factor; SARS-CoV-2, severe acute respiratory syndrome coronavirus 2; ANOVA, analysis of variance.



and 5 (5.1%) had died. Six patients (one ICU and five general ward patients) were transferred to other tertiary care hospitals because our medical resources were exhausted. All of the other patients are still in the hospital. Because our hospital is a tertiary care university hospital, with many patients requiring intensive care, the fatality rate is likely higher than the overall mortality rate in Korea. However, the fatality rate in our study was much lower than rates reported in three single-center studies of hospitalized COVID-19 patients in Wuhan, China.<sup>1,2,12</sup> Since there will be additional deaths among patients who remain in the hospital, the final fatality rate is expected to increase.

Table 3 shows the laboratory findings of the patients on admission to hospital. In the complete blood counts, lymphopenia (40.8%) was the most common finding, followed by anemia (24.5%), neutrophilia (20.4%), and thrombocytopenia (13.3%). In blood chemistry analyses, increased lactate dehydrogenase (50.5%) was common.

Among infection-related biomarkers, C-reactive protein was elevated in 61 (67.8%) patients, while procalcitonin was increased only in 6 (6.2%). Fig. 1 shows the concentrations of the proinflammatory cytokines interleukin-1 $\beta$  (IL-1 $\beta$ ), IL-4, IL-6, IL-10, interferon- $\gamma$  (IFN- $\gamma$ ), and tumor necrosis factor- $\alpha$  (TNF- $\alpha$ ) in the SARS-CoV-2-infected patients [n=40 (ICU, n=10)]. Levels of all proinflammatory cytokines were significantly higher in ICU patients than in non-ICU patients in our study. Previous studies have demonstrated that increases in proinflammatory cytokine levels are associated with more severe disease in Middle East respiratory syndrome and severe acute respiratory syndrome patients. In patients with Middle East respiratory syndrome in South Korea, IL-6 and CXCL-10 levels were significantly higher in the severe disease group than in the mild group.<sup>14</sup> In severe acute respiratory syndrome patients, the levels of inflammatory cytokines IL-1, IL-6, IL-12, and IFN- $\gamma$  were elevated.<sup>15</sup> To prevent organ damage from cytokine release syndrome, it is imperative to develop a drug that targets these cytokines.

The severity of respiratory illness and results of arterial blood gas analyses of 13 ICU patients on the day of ICU admission were also measured. The mean interval from hospital admission to ICU admission was 1.2 $\pm$ 1.5 days. On the day of ICU admission, the mean APACHE II score was 19.6 $\pm$ 7.1, and the mean SOFA score was 7.4 $\pm$ 3.2. The mean pH, lactate level, mean partial pressure of oxygen/fraction of inspired oxygen ratio, and mean partial pressure of carbon dioxide were 7.4 $\pm$ 0.1, 1.7 $\pm$ 0.8 mmol/L, 174.5 $\pm$ 44.9, and 39.8 $\pm$ 9.5, respectively.

A limitation of this study was that it was conducted at a single medical center and included a small number of patients. However, this study identified many predictors of the likely requirement for ICU care. We also found that proinflammatory cytokine levels were higher in patients with severe disease. A second limitation was the fact that this study did not include the patients' final clinical outcomes. Further analysis will be

needed when the COVID-19 pandemic ends and final outcome data are available.

This is the first study to describe the clinical characteristics of hospitalized patients with SARS-CoV-2 in South Korea. In this single-center descriptive study of 98 patients hospitalized with SARS-CoV-2 in Daegu, South Korea, 13.3% of the patients received ICU care. As of March 29, 2020, the mortality rate was 5.1%.

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