The urgency of severity and mortality risk assessments for COVID-19: A summary from death cases in Wuhan, China

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Abstract

Background To investigate the clinical characteristics of 21 death cases and evaluate potential factors of disease severity and mortality risk in COVID-19.

Methods Retrospective analysis was used to study the clinical data of 21 death cases with COVID-19. The assessment of disease severity and mortality risk were conducted by APACHE II, SOFA, MuLBSTA and PSI scores.

Results The age was 66 ± 14 years-old and 15 (71.4%) were men. 16 (76.2%) patients had chronic medical illnesses. 12 (57.1%) patients were overweight. Decreased lymphocytes were observed in 17 (81.0%) patients on admission. Elevated D-dimer levels were noticed in 11 (52.4%) patients and increased much more when pneumonia deteriorated. The initial APACHE II and SOFA scores demonstrated 18 (85.7%) and 13 (61.9%) patients in middle-risk levels, respectively. MuLBSTA and PSI scores after admission showed high-risk mortality in 13 (61.9%) patients. Most patients developed sequent organ failure and finally caused death.

Conclusion Older, male, overweight patients, combined with chronic medical histories, continuous decreased lymphocyte proportion and increased D-dimer might have a higher risk of death. The combination of general scoring (SOFA) and pneumonia specific scoring (MuLBSTA and PSI) after admission might be more sensitive to assess the mortality risk for critical patients in COVID-19.

Background

Coronavirus disease 2019 (COVID-19) is an infectious disease which outbreak since early December, 2019. On Jan 20, 2020, it was identified that COVID-19 could spread from person to person through the respiratory tract by National Health Commission (NHC) of China. As of Mar 24, 2020, more than 370,000 patients suffered from this disease around the world. Severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), the pathogen of COVID-19, was found to cause acute respiratory distress syndrome (ARDS), myocardial injury, kidney and liver damages, coagulation abnormality[1, 2] and maybe central nervous system lesion (confirmed but unpublished by Beijing Ditan Hospital). All these organ dysfunctions accelerated disease progression and could lead to death[1, 3]. It has caused more than 18,000 deaths up to Mar 24 all over the world. The two homologous coronaviruses, severe acute respiratory syndrome coronavirus (SARS-CoV) and Middle East respiratory syndrome coronavirus (MERS-CoV), have caused more than 1700 deaths in the past two decades, with mortality rates of more than 10% in SARS and 37% in MERS[4]. SARS-CoV-2 seems to have a stronger infectivity and a relatively weaker lethality than SARS-CoV and MERS-CoV.

In a recent single-center study, SARS-CoV-2 caused a mortality rate up to 61.5% in critical patients[1]. Another single-center research pointed out the potential relationship between older age, respiratory failure, multiorgan dysfunction and mortality[5]. One multi-center retrospective cohort study analyzed risk factors for death in adults COVID-19, and identified that older age, elevated D-dimer levels and higher SOFA score

on admission were associated with higher risk of in-hospital mortality[2]. These researches helped clinicians understand the clinical features of death cases and probable risk factors of mortality in COVID-19 to some extent. However, under the pandemic situation and the relatively insufficient medical resources in the world, we need to find some useful methods or assessment tools to identify the severity and mortality risk in COVID-19 as early as possible.

In this retrospective, descriptive and single-center study, we enrolled 21 death cases who were confirmed COVID-19 and admitted to Zhongnan Hospital of Wuhan University. The clinical characteristics and several influential factors would be presented. The evaluations of disease severity and mortality risk would be calculated through different scoring systems, which could suggest a more cautious assessment and identification at early phase of disease. Thus, more intensive care and beneficial treatment will be offered to certain individuals at a high risk of progressing quickly to critical cases to reduce mortality and disability rate.

Methods

Study design and participants

In this retrospective and descriptive study, we enrolled 21 patients admitted to emergency intensive care unit (EICU) in Zhongnan Hospital of Wuhan University from Jan 3 to Feb 15, 2020. Zhongnan Hospital of Wuhan University is one of the major COVID-19 designated hospitals. All cases in the study were diagnosed as COVID-19 by laboratory detection according to World Health Organization interim guidance[6]. The study was approved by Zhongnan Hospital Ethics Committee (No.2020005) and written informed consent was waived due to the rapid emergence of this infectious disease. These patients have not been reported in any other submission.

Procedures and Data collection

We collected and scanned the electronic medical records of 21 death cases. Demographic, epidemiological, clinical, laboratory and radiological characteristics, nursing records, treatment and outcomes data were obtained and reorganized using a standardized data collection form (a modified form for severe acute respiratory infection clinical characterization shared by the International Severe Acute Respiratory and Emerging Infection Consortium). The key duration from the first symptoms to death were recorded. The assessment of disease severity and organ dysfunction were also brought into study. Acute Physiology and Chronic Health Evaluation II (APACHE II), sepsis-related organ failure assessment (SOFA), Multilobular infiltration, hypo-Lymphocytosis, Bacterial coinfection, Smoking history, hyper-Tension and Age (MuLBSTA) and pneumonia severity index (PSI) scores were calculated according to accepted standards since admission. The data (including images) were reviewed by two advanced physicians or radiologists to ensure accuracy.

Outcomes

The primary outcomes were the early evaluations of disease severity and mortality risk through standard scoring systems. Various original and statistical data or images described in the above-mentioned procedures were also summarized and analyzed. All data were objective and certified.

Statistical analysis

Continuous variables were described as mean $\pm$ standard deviation (SD) or median (25-75% interquartile) and categorical variables as number (percentages). All statistical analyses were performed with SPSS software (version 25.0, IBM Inc).

Results

Baseline Characteristics and Pre-hospital Treatment

The study included 21 death cases with confirmed COVID-19, none of which had an exposure history to Huanan Seafood Market. As shown in Table 1, the mean age was 66 ± 14 years-old, and 10 (47.6%) were older than 70 years-old. 15 (71.4%) patients were men. 12 (57.1%) patients were overweight by calculating BMI. Of the 21 patients, 16 (76.2%) had coexisting chronic medical illnesses and 9 patients suffered more than one illness. Before admission, the most common symptoms were fever (18, 85.7%), shortness of breath (16, 76.2%) and dry cough (11, 52.4%). In patients with fever, 4 (19.0%) had a highest temperature under 38.0°C , 6 (28.6%) in $38.1-39.0^{\circ}\text{C}$ and 4 (19.0%) above 39.0°C before admission. The temperatures of another 4 (19.0%) fever patients were vague and not included here. While, 14 (66.7%) patients were in normothermia on admission. 19 (90.5%) patients received treatment in outpatient department because of a lack of beds and 1 (4.8%) patient accepted residential treatment in other hospital before admission. 13 (61.9%) of these patients were treated with antibiotic drugs, 8 (38.1%) with antiviral drugs, 1 (4.8%) with systemic corticosteroid and 1 (4.8%) with immunoglobulin. In the study, the durations from first symptoms to admission were 5 ± 3 days. 19 (90.5%) patients were classified as severe status and 2 (9.5%) as critical status on admission according to the guidelines for Diagnosis and Treatment of COVID-19 (7th edition) published by NHC. Most patients showed tachypnea with a respiratory rate of 24 ± 6 times/minute and 2 (9.5%) patients over 30. We also analyzed the images within 24 hours before or immediately after admission to ascertain pulmonary lesions before the initiation of our treatment. All the 21 patients showed bilateral multiple ground-glass opacity on CT or X-ray scans. Bilateral injuries from superior to inferior lobes appeared in 19 (90.5%) patients. The rest two patients showed abnormal regions either in superior or inferior fields. The involved area of 12 (57.1%) patients exceeded 50%, showing extensive effusion and consolidation.

Vital Laboratory Parameters and Imaging Features

On admission, leucocytes were below the normal range in 8 (38.1%) patients and above the normal range in 3 (14.3%) patients (table 2). Procalcitonin (PCT), interleukin-6 (IL-6) and C-reactive protein (CRP) were

generally higher than normal. Leucocytes and neutrophils increased in accordance with the infectious indicators when co-infection with bacterial outbreak. Lymphocytes below the normal range were observed in 17 (81.0%) patients with a value of $0.7 \pm 0.5 \times 10^9/L$ on admission. Also, platelets were below the normal range in 11 (52.4%) patients. Lymphocyte percentage and platelets decreased gradually with inflammation progression (Figure 1), which was a feature of COVID-19 in the study. Decreased albumin levels were observed in most patients. Bio-markers reflecting organ functions are displayed on the Table 2. The maximum of high-sensitive troponin I (hs-TnI) exceeded 50000 pg/ml in a patient with acute myocardial infarction. PT increased to a relative higher level as condition worsened (Figure 1). Elevated serum D-dimer were noticed in 11 (52.4%) patients on admission and the proportion increased to 100% when pneumonia deteriorated.

Chest CT or X-ray was conducted at approximately 3-day intervals. Representative radiologic findings of two patients were presented in Figure 2. On admission, multiple ground-glass opacity and exudation appeared in bilateral subpleural areas. Lesions expanded rapidly just in several days and manifested as ground-glass opacity and air bronchograms coexisting with extensive consolidation or fibrous stripes. A white lung appearance could be always seen in end-stage COVID-19.

Severity of Illness Scores

In the study, we evaluated severity, progression and prognosis of patients' condition by figuring APACHE II, SOFA, MuLBSTA and PSI scores dynamically. In Table 3, we presented different levels of the four scores after admission, before ventilation and the maximum in the course. The initial APACHE II and SOFA scores were 14 ± 3 and 7 (5-8) respectively. 18 (85.7%) and 13 (61.9%) patients were in the middle-risk levels of each. Both APACHE II and SOFA scores increased before ventilation and more patients reached the high-risk levels in accordance with the deterioration of patients' condition and the urgent requirement for non-invasive or invasive ventilation. We found 13 patients were over 12 points of MuLBSTA on admission which predicted a high risk of death. But no significant fluctuation of MuLBSTA score was observed from admission to ventilation. Same changes were observed in PSI. The PSI score was 137 (102-146) after admission and 138 (125-157) before ventilation, with 13 (61.9%) patients over 130 in the high-risk level in both stages. All the four scores reached a maximum just before death including the same 19 (90.5%) patients in each high-risk level, with a median of APACHE II 26 (22-32) points, SOFA 14 (12-16) points, MuLBSTA 15 (13-16) points and PSI 163 (149-185) points, implying a very high mortality.

Main Interventions and Complications

Patients with COVID-19 were treated in isolation. In Table 4, all the patients received antiviral treatment after admission including intravenous potassium sodium dehydroandroan drographolide succinate and oral oseltamivir or lopinavir and ritonavir tablets, abidol hydrochloride tablets latter according to guidelines of NHC. Also, all patients were given empirical antibiotic treatment covering common pathogens and some atypical pathogens. In patients (18, 85.7%) with secondary bacterial infection or septic shock, higher-level and combined antibiotics such as carbapenems and anti-gram positive drugs

were administered according to bacterial culture and drug sensitivity. 2 (9.5%) patients were treated with antifungal drugs. 16 (76.2%) patients received systemic corticosteroids with an initial dose of 1-2mg/kg per day on the basis of patient's condition and 3 (14.3%) patients were given large dose of immunoglobulins. Low molecular weight heparin was subcutaneously administered for prophylactic anticoagulation in patients of hypercoagulable state. 14 (67%) patients received high-flow nasal cannula oxygen therapy. 8 (38.1%) patients were given intermittently or continuous non-invasive ventilation for 1-11 days after a duration of 1 (0-5) day from admission. Invasive ventilation was required in 18 (85.7%) patients after a duration of 4 ± 3 days from admission. A total of 19 patients were given norepinephrine to correct hypotension. 6 (28.6%) patients received renal replacement therapy owing to renal failure, among whom 2 patients had a long-term regular hemodialysis for chronic renal diseases. Another 3 (14.3%) patients had refractory hypoxaemia and received extracorporeal membrane oxygenation (ECMO) as salvage therapy, including one after successful cardiopulmonary resuscitation.

The total course from first symptoms to death was 18 ± 8 days with a duration of 12 (8-17) days in hospitalization. Patients died within 8 ± 5 days after invasive ventilation. In the disease progression, all patients were diagnosed as severe pneumonia followed by ARDS and a majority of patients (19, 90.5%) developed multiple organ dysfunction. Acute renal, liver and cardiac injury were developed in 17 (81.0%), 12 (57.1%) and 7 (33.3%) patients respectively. Another 2 patients suffered fatal acute myocardial infarction or upper gastrointestinal and died in convalescence stage of pneumonia. All patients developed to coagulation abnormality. Secondary infections were observed and evolved into septic shock in 18 (85.7%) patients. Hospital-acquired infection was noticed in 5 (23.8%) patients. Multidrug-resistant *Cinetobacter baumannii* infection was identified from sputum in 3 (14.3%) patients, one of whom had a co-infection with *Escherichia coli*. *Corynebacterium striatum* was identified in the blood culture of 1 (4.8%) patient. Another patient was diagnosed as urinary tract infection with urine culture of *Candida glabrata*.

Discussion

COVID-19 has spread in more than 100 countries up to late March, which is much more infectious and invasive than SARS and MERS[4]. The severe cases reached a peak of 11977 (16.1%) on Feb 18th and gradually decreased later in China according to data published by NHC. The total mortality 4.0% (March 26th) is much lower than SARS in 2003 and MERS in 2015[4]. However, the mortality in severe patients exceeded 60% in previous report[1]. In this single-center and retrospective study, we described and analyzed the demographic and clinical characteristics of 21 death cases with confirmed COVID-19 in EICU of Zhongnan Hospital of Wuhan University.

Males (71.4%) were major victims here in this study similar with other researches in different hospitals[1, 2, 5]. The mean age was 66 years with almost a half over 70 years. Combining with COVID-19 studies in other centers during the same period, older males seem more susceptible to SARS-CoV-2 infection and

are the primary members in severe group with poor prognosis[1, 2, 5], which is supported by our data. Same findings were reported in previous SARS[7, 8] and MERS studies[9, 10]. We found overweight adults account for more than half in the study, which was ignored before. We should also pay attention that a few patients suffered self-healing diarrhea during the course. The mean time from illness onset to hospital admission was 5 days, less than 11 days presented in the research conducted in Jinyintan Hospital and Wuhan Pulmonary Hospital[2]. 20 patients had received oral or intravenous medication treatments before admission including antibiotic and antiviral therapy mostly. However, no drugs seemed effective to delay the progression of COVID-19 in the early stage of the epidemic.

In laboratory tests, reduced lymphocytes, a characteristic index in SARS-CoV-2 infection, were observed in majority patients in our study, which is also mentioned in many other reports[3, 11, 12]. We speculate the continuous lymphocyte proportion decrease may indicate excessive consumption by SARS-CoV-2 like the mechanism in SARS-CoV and MERS-CoV infection[13, 14]. Lymphopenia seemed more common in severe patients[2, 3] and might reflect the severity and higher mortality of COVID-19. Lymphocyte subpopulation was detected and both CD4-positive and CD8-positive T lymphocytes decreased significantly. Damage of T lymphocytes and inhibition of the cellular immune system may contribute great to the deterioration. Levels of serum IL-6 increased rapidly in a short period, which could be explained by the active inflammatory storm[5, 6]. In this study, we detected reduced platelets on admission and progressive decline during hospitalization, which were previously demonstrated to have a relation with severe inflammation[15, 16]. Urea and creatinine rose in different degrees represented renal dysfunction because of virus invasion, hypoxaemia, hypoperfusion or original kidney diseases. Coagulation dysfunction was observed in almost all cases marked by prolonged PTs and significant increased serum D-dimer concentrations.

Despite of many clinical assessment and prediction scores, there is no standard recommendation to predict the severity and risk of mortality for patient with viral pneumonia up to now. Viral pneumonia, including COVID-19, might progress rapidly to critical illness and develop to ARDS, multiple organ failure and even death. APACHE II scoring system has been widely used to assess patient severity and predict outcome in critical ill patients[17]. SOFA scoring has also been used to predict prognosis and assist the diagnosis of sepsis/septic shock in intensive care unit (ICU). In our study, the APACHE II and SOFA scores on admission were 14 ± 3 and 7 (5-8) respectively. The highest APACHE II and SOFA scores were 26 (22-32) and 14 (12-16), respectively. They both increased along with the progression of disease. The SOFA score was similar with the non-survivors at ICU admission in one study about COVID-19 critically ill patients[3, 6], however, the APACHE II score was similar with the survivors. Another study found that higher SOFA score at admission was associated with higher odds of death in COVID-19 patients[2]. This study did not present the APACHE II score in article. SOFA scores, including mean and highest SOFA scores, are both good predictors for prognosis. Independent of the initial score, an increase of SOFA score during the first 48 h predicts a mortality rate of 50% [18]. On the other hand, SOFA score is the diagnostic marker for sepsis/septic shock [19]. In our study, 18 (85.7%) of patients developed septic shock. As the study demonstrated that more than 50% of COVID-19 patients developed sepsis[2], which reminded us the possibility of virus induced sepsis syndrome besides SARS-CoV-2 infection combined bacterial

infection. APACHE II score 10-20 suggests the mortality rate of about 50%, and above 20 suggests the mortality rate of about 80%. Although existing difference between studies aforementioned, we still considered that APACHE II score had its general predictability for outcome in COVID-19, which might be less sensitive enough than SOFA score.

In our study, we conducted two special scores to predict the probability of mortality in pneumonia, MuLBSTA[20] and PSI [21]. Both score results in our study showed that 13 (61.9%) patients had the high risk of mortality at admission. The highest scores increased to 15 (13-16) (MuLBSTA) and 163 (149-185) (PSI), respectively, accounting for 19 (90.5%) patients. Up to now, there is few research analyzing pneumonia special severity scoring system in SARS-CoV-2 infected pneumonia. One research about COVID-19 mortality analysis found that CURB-65 score was significantly higher in non-survival groups than survival groups[2]. Our study identified the usefulness of MuLBSTA and PSI scoring systems in predicting the risk of mortality in COVID-19. However, the accurate sensitivity and specificity of those pneumonia special severity scoring systems needs further research and verification.

All the death cases showed complications, mainly including ARDS (100%), septic shock (85.7%), acute kidney injury (81.0%), liver dysfunction (57.1%) and acute cardiac injury (33.3%), which had been also observed in similar researches[2, 5, 6]. The primary cause of progressive impact on multiorgan by SARS-CoV-2 is that the binding receptor for SARS-CoV-2, ACE2 mainly exists in blood vessels and lung alveolar type II (AT2) epithelial cells [22]. And ACE2 also exists in the heart, kidney, liver and so on. Thus, the viral infection may stimulate the immune cells to release pro-inflammatory cytokines and damage the target organs, even causing death.

The treatments for COVID-19 mainly covered anti-pathogen therapy, different kinds of oxygen therapy, glucocorticoid therapy, immunoglobulin therapy, and advanced life support for organ function, which were similar with published researches[2, 5, 6, 11]. 9 (42.9%) patients received low molecular heparin therapy in our study. During the treatment of the COVID-19 patients, coagulation abnormalities can be observed through laboratory findings mostly, including D-dimer, prothrombin time and so on, but not all the cases may develop to some detectable relative clinical manifestations. In a large retrospective cohort study about COVID-19, researchers found that elevated D-dimer, greater than 1 μ g/L, at admission was a risk factor for mortality in adult patients with COVID-19 [2]. The final impacts of coagulation abnormalities could be understood according to the lung biopsy conducted by Shenzhen Third People's Hospital [23]. The whole lung tissue displayed a diffuse congestive appearance with variable degrees of hemorrhagic pulmonary infarction and microthrombosis formation prominently presented in outer edge of the lung. The biopsy also pointed out that hemorrhagic necrosis in the outer edge of the lung might be the origination of COVID-19 and one of the main causes of death in severe patients. Coagulation abnormalities can be observed in severe pneumonia and sepsis. In a study of community-acquired pneumonia, D-dimer had been found to elevate persistently in 86.5% of patients, even among the least ill cases[24]. The research about patients with infection or sepsis identified in the emergency department showed that high levels of D-dimer was associated with 28-day mortality[25]. These findings highlighted

the complexity of the coagulation response to viral infection and corresponding coagulation-based therapeutics.

Limitations

There are several limitations in this study. Firstly, this is a retrospective, descriptive, single-center study with a small sample. The further large cohort study or some random controlled trials are needed to confirm our findings. Secondly, some cases had incomplete or missing data, including outpatient information, laboratory results in certain periods, sequential images and so on, which would influence the analysis accuracy in the study.

Conclusions

Older, male, overweight patients, combined with chronic medical histories, continuous decreased lymphocyte proportion, and increased serum D-dimer levels might have a higher risk of death. The combination of general scoring (SOFA score) and pneumonia specific scoring (MuLBSTA score and PSI score) after admission might be more sensitive to assess the risk of mortality for critically ill patients in COVID-19. We suggested a high attention and further study to coagulation abnormalities and relevant definitive therapy in COVID-19.

Declarations

Ethics approval and consent to participate The study was approved by Zhongnan Hospital Ethics Committee (No.2020005) and written informed consent was waived due to the rapid emergence of this infectious disease.

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Availability of data and materials Not applicable

Competing interests All authors declare no competing interests.

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Authors' Contributions Jian Xia, Cheng Jiang and Yan Zhao had the idea for and designed the study and had full access to all data in the study and take responsibility for the integrity of the data and the accuracy of the data analysis. Feihong Yang and Jiaohong Gan contributed to writing of the report. Cheng Jiang contributed to critical revision of the report. Hao Zou and Zhongxiang Zhang contributed to the statistical analysis. All authors contributed to data acquisition, data analysis, or data interpretation, and reviewed and approved the final version.

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Tables

Clinical characteristics	Patients (n=21)
Age, years	66±14
Sex	
Male	15 (71.4%)
Female	6 (28.6%)
History of smoking	
Positive	3 (14.3%)
Negative	18 (85.7%)
Body mass index, kg/m ²	25.1±4.5
<18.5	2 (9.5%)
18.5-23.9	7 (33.3%)
>23.9	12 (57.1%)
Chronic medical illness	
Cardiovascular diseases	9 (42.9%)
Urinary system diseases	5 (23.8%)
Cerebral vascular diseases	4 (19.0%)
Lung diseases	4 (19.0%)
Diabetes mellitus	3 (14.3%)
Major symptoms on admission	
Fever	18 (85.7%)
Shortness of breath	16 (76.2%)
Dry cough	11 (52.4%)
More than one sign and symptom	19 (90.5%)
Fever, dry cough and shortness of breath	7 (33.3%)
Highest temperature before admission	38.6±0.6
<37.3°C	3 (14.3%)
37.3-38°C	4 (19.0%)
38.1-39°C	6 (28.6%)
>39°C	4 (19.0%)
Missing	4 (19.0%)
Fever on admission	
Yes	7 (66.7%)
No	14 (33.3%)
Treatment before admission	
Outpatient service	19 (90.5%)
Hospitalization elsewhere	1 (4.8%)
Antibiotic therapy	13 (61.9%)
Antiviral therapy	8 (38.1%)
Systemic corticosteroid therapy	1 (4.8%)
Immunoglobulin therapy	1 (4.8%)
No treatment	1 (4.8%)
Days from first symptoms to admission	5±3
Days from first symptoms to death	18±8
Days from admission to death (hospital stay)	12 (8-17)
Days from admission to non-invasive ventilation	1 (0-5)
Days from admission to invasive ventilation	4±3
Days from invasive ventilation to death	8±5
Disease severity status	
Severe	19 (90.5%)
Critical	2 (9.5%)
Respiratory rate on admission (times/min)	24±6

> 30 times/min	2 (9.5%)
Imaging features on admission	
Bilateral involvement	21 (100.0%)
All fields	19 (90.5%)
Upper fields	1 (4.8%)
Lower fields	1 (4.8%)
Involved area > 50%	12 (57.1%)
Involved area < 50%	9 (42.9%)

Table 1. Baseline clinical characteristics on admission of 21 patients with confirmed COVID-19.

Findings	Admission	Increase/decrease (n=21)	Maximum	Minimum
WBC (×10 ⁹ /L, 3.5-9.5)	10.5±8.2	8(38.1%) / 3(14.3%)	20.8±8.4	7.7±5.1
Platelets (×10 ⁹ /L, 1.1-3.2)	0.7±0.5	0 / 17(81.0%)	1.3±0.9	0.3±0.3
Prothrombin time (s, 11.5-14.5)	13.9±2.8	0/19(90.5%)	11.7±8.1	2.3±1.6
INR (1.0-1.5)	1.2±0.2	10(47.6%) / 0	19.3±8.3	6.6±4.6
ALT (U/L, 0-40)	129.1±24.4	3(14.3%) / 4(19.0%)	134.4±24.5	108.0±26.1
AST (U/L, 0-40)	140±66.2	0 / 11(52.4%)	173.2±74.1	70.9±54.1
Albumin (g/L, 35-55)	3.1±5.6	21(100.0%) / 0	11.3±14.8	1.1±1.9
Bilirubin (mg/dL, 0.2-1.2)	77.0±23.7	5/5(100%) / 0	472.5±405.8	33.3±20.5
Cr (mg/dL, 0.6-1.3)	125.4±74.0	20(95.2%) / 0	230.9±107.0	88.9±85.6
Urea nitrogen (mg/dL, 8-20)	38.8±20.1	7(33.3%) / 0	125.1±237.7	22.6±10.8
Glucose (mg/dL, 70-130)	66.0±33.9	16(76.2%) / 0	309.6±733.5	33.6±18.1
Uric acid (mg/dL, 2.4-8.4)	16.6±6.7	6(28.6%) / 0	30.1±16.4	13.6±6.1
Procalcitonin (pg/mL, 0-10)	8.4±5.0	9(42.9%) / 0	16.4±11.4	4.9±3.1
CRP (mg/L, 0-10)	61.2±8.1	0 / 14(66.7%)	65.8±7.8	53.6±7.1
ESR (mm/h, 0-100)	32.1±5.6	0 / 20(95.2%)	34.9±3.4	25.2±4.6
D-dimer (ng/mL, 0.1-0.5)	9.9±6.1	15(71.4%) / 1(4.8%)	15.7±7.1	7.9±2.9
LDH (U/L, 100-250)	10.1±7.2	10 (47.6%) / 0	22.6±11.8	8.7±6.8
Prothrombin time (s, 11.5-14.5)	168.5±251.1	9 (42.9%) / 0	333.9±350.3	113.6±157.9
INR (1.0-1.5)	4.0±0.7	2(9.5%) / 6(28.6%)	5.1±0.9	3.7±0.7
ALT (U/L, 0-40)	137.8±9.5	3(14.3%) / 10(47.6%)	152.3±13.5	135.6±7.9
AST (U/L, 0-40)	504.6±1623.63	7(33.3%) / 0	1283.4±2110.4	86.7±221.8
Albumin (g/L, 35-55)	3.3±3.2	2(9.5%) / 0	15.8±22.1	1.8±2.0
Bilirubin (mg/dL, 0.2-1.2)	166.6±188.2	6(28.6%) / 0	504.8±567.4	157.5±162.1
Cr (mg/dL, 0.6-1.3)	13.6±2.3	11(52.4%) / 0	20.2±12.4	12.4±1.5
Urea nitrogen (mg/dL, 8-20)	452.7±116	5(23.8%) / 0	546.0±99.4	314.6±140.0
Glucose (mg/dL, 70-130)	2726.4±4538.2	11(52.4%) / 0	24311.9	1654.2
Uric acid (mg/dL, 2.4-8.4)			± 36589.9	± 3162.1

Table 2. Laboratory results of 21 patients including the baseline values on admission and the maximum, minimum values during hospitalization.

Scores	Admission	Before ventilation	Maximum
APACHE II	14±3	17±4	26 (22-32)
< 10	1 (4.8%)	0	0
10-19	18 (85.7%)	13 (61.9%)	2 (9.5%)
≥ 20	2 (9.5%)	8 (38.1%)	19 (90.5%)
SOFA	7 (5-8)	8 (7-12)	14 (12-16)
0-5	8 (38.1%)	2 (9.5%)	0
6-10	13 (61.9%)	11 (52.4%)	2 (9.5%)
> 11	0	8 (38.1%)	19 (90.5%)
MuLBSTA	13±2	13±2	15 (13-16)
> 12 (High risk)	13 (61.9%)	14 (66.7%)	19 (90.5)
< 12 (Low risk)	8 (38.1%)	7 (33.3%)	2 (9.5%)
PSI	137 (102-146)	138 (125-157)	163 (149-185)
71-90	3 (14.3%)	1 (4.8%)	0
91-130	5 (23.8%)	7 (33.3%)	2 (9.5%)
> 130	13 (61.9%)	13 (61.9%)	19 (90.5%)

Table 3. Severity assessment of APACHE II, SOFA, MuLBSTA and PSI scores on admission, before ventilation and the maximum value during hospitalization in 21 patients.

Main intervention and complications	Patients (n=21)
Main interventions	
Antiviral therapy	21 (100%)
Antibiotic therapy	21 (100%)
Antifungal therapy	1 (4.8%)
Systemic corticosteroids therapy	16 (76.2%)
Immunoglobulin therapy	3 (14.3%)
Low molecular heparin therapy	9 (42.9%)
High-flow nasal cannula oxygen therapy	14 (66.7%)
Mechanical ventilation	
Non-invasive mechanical ventilation	8 (38.1%)
Invasive mechanical ventilation	18 (85.7%)
Continuous renal replacement therapy	6 (28.6%)
Extracorporeal membrane oxygenation	3 (14.3%)
Norepinephrine therapy	19 (90.0%)
Main complications	
Acute respiratory distress syndrome	21 (100%)
Multiple organ dysfunction syndrome	19 (90.5%)
Acute kidney injury	17 (81.0%)
Liver dysfunction	12 (57.1%)
Acute cardiac injury	7 (33.3%)
Coagulation abnormality	
Secondary infection	18 (85.7%)
Septic shock	18 (85.7%)
Hospital-acquired infection	5 (23.8%)

Table 4. Main Interventions and complications of 21 patients during hospitalization

Figures

Figure 1

Results of laboratory examination during hospitalization

Figure 2

CT images from a female over 75-year-old (A, B, C) and a male over 70-year-old (D, E, F) COVID-19 patients. (A) Day 6 after symptoms onset: multifocal patchy ground-glass opacities in bilateral subpleural areas. (B) Day 9 after symptoms onset: expansion of bilateral pulmonary lesions and denser pulmonary consolidation. (C) Day 15 after symptoms onset: extensive ground-glass opacities in both sides showing a white lung appearance with air bronchograms. The patient died 7 days after the final scan. (D) Day 7 after symptoms onset: multifocal patchy ground-glass opacities in bilateral areas. (E) Day 11 after symptoms onset: enlarged crescent ground-glass opacities in both subpleural areas. (F) Day 14 after symptoms onset: extensive ground-glass opacities with obvious air bronchograms in bilateral areas. The patient died of anteroseptal ST-segment elevation myocardial infarction 3 days after the final scan.