Characteristics and outcomes of hemodialysis patients with COVID-19

Cheng'an Cao [1], **zhifen Liu** [2], **Heping Yu** [3], **Xiang Peng** [1], **Yongwen Luo** [Corresp. 4]

[1] Department of Neurology, Wuhan Fourth Hospital, Wuhan, China, China

[2] Department of Nephrology, Wuhan Fourth Hospital, Wuhan, China, China

[3] Nail and breast surgery Department, Wuhan Fourth Hospital, Wuhan, China, China

[4] Department of Urology and Nephrology, Zhongnan Hospital of Wuhan University, Wuhan, China, China

Corresponding Author: Yongwen Luo
Email address: luoywen@whu.edu.cn

Background Since December, 2019, with the outbreak of coronavirus disease 2019 (COVID-19) it has now spread throughout the world, COVID-19 is now considered a globally pandemic. Previous studies mostly focus on general population with COVID-19 infection. Currently, clinical information about COVID-19 in hemodialysis patients is lacking. **Methods** In this retrospective, single-centre study, we included 16 hemodialysis patients with COVID-19 from Feb. 5th to Mar. 20th, 2020, in Wuhan Fourth Hospital. Moreover, 62 general patients with COVID-19 were included as control group. Clinical characteristics, treatments, and clinical outcomes were analyzed. **Results** Compared with general patients with COVID-19 infection, hemodialysis patients presented lower incidence of fever($p=0.001$) and relatively higher incidence of preadmission comorbidities and shortness of breath (75%vs 61%; 50% vs 33.87%). hemodialysis patients had a lower level of hemoglobin ($p<0.001$), white blood cell count ($p=0.015$), neutrophil ($p=0.016$), AST ($p=0.037$), ALT ($p<0.001$) and procalcitonin ($p<0.001$), and higher level of D-dimer($p<0.001$) and TT ($p<0.001$). higher incidence of pulmonary effusion, cord high density shadows, pleural thickening, atelectasis were observed in hemolysis patients($p<0.05$). As clinical outcomes, hemodialysis patients showed relatively higher mortality and prolonged hospital stay. **Conclusion** Hemodialysis patients were a high-risk group of COVID-19 infections, as hemodialysis patients often had multiple comorbidities, worse physical condition, patients with COVID-19 may have prolonged hospital stay unfavorable prognosis, COVID-19 infection should be monitored intensively for hemodialysis patients.

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Yongwen Luo, MD[1*]; zhifen Liu, MD[2]; Heping Yu, MD [3]; Xiang Peng, MD[4*]; Cheng'an Cao, MD [4*]

[1] Department of Urology and Nephrology, Zhongnan Hospital of Wuhan University, Wuhan, China.

[2] Department of Nephrology, Wuhan Fourth Hospital, Puai Hospital, Tongji Medical College, Huazhong University of Science and Technology, Wuhan, China.

[3] Nail and breast surgery Department, Wuhan Fourth Hospital, Puai Hospital, Tongji Medical College, Huazhong University of Science and Technology, Wuhan, China.

[4] Department of Neurology, Wuhan Fourth Hospital, Puai Hospital, Tongji Medical College, Huazhong University of Science and Technology, Wuhan, China.

[*]**Corresponding author:** Dr. Luo, Email: luoywen@whu.edu.cn, Tel. +86-17740522459; Dr. Cao, Email: cca24@126.com, Tel. +86-15062322634.

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Abstract

Background with the outbreak of coronavirus disease 2019 (COVID-19) in December, 2019, it has spread throughout the world. COVID-19 is now considered a global pandemic. Currently, clinical information about hemodialysis patients with COVID-19 is scarce.

Methods In this retrospective, single-center study, we recruited 16 hemodialysis patients with COVID-19 from Feb. 5th to Mar. 20th, 2020, in Wuhan Fourth Hospital. Moreover, 62 nondialysis patients with COVID-19 were included as control group. The clinical characteristics, laboratory finding, treatment, and clinical outcomes were collected for the assessment.

Results Compared with nondialysis patients with COVID-19 infection, hemodialysis patients presented lower incidence of fever($p=0.001$) and relatively higher incidence of preadmission comorbidities and shortness of breath (75%vs 61%; 50% vs 33.87%). hemodialysis patients had a lower level of hemoglobin ($p<0.001$), white blood cell count ($p=0.015$), neutrophil ($p=0.016$), AST ($p=0.037$), ALT ($p<0.001$) and procalcitonin ($p<0.001$), and higher level of D-dimer($p<0.001$) and TT ($p<0.001$). higher incidence of pulmonary effusion, cord high density shadows, pleural thickening, atelectasis were observed in hemolysis patients($p<0.05$). As clinical outcomes, hemodialysis patients showed relatively higher mortality and prolonged hospital stay.

Conclusion Hemodialysis patients were a high-risk group of COVID-19 infections, as hemodialysis patients often had multiple comorbidities, worse physical condition, patients with COVID-19 may have prolonged hospital stay unfavorable prognosis, COVID-19 infection should be monitored intensively for hemodialysis patients.

Since December 2019, with the outbreak of coronavirus disease 2019 (COVID-19), it has now spread throughout the world [1], COVID-19 is now considered a globally pandemic by the World Health Organization. As of April 5, 2020, a total of 1133758 cases have been confirmed and 62784 deaths have been reported across 209 countries or regions [2]. Previous studies have showed that the elderly are susceptible to COVID-19 infection, particularly those with chronic comorbidities [3, 4]. The initial COVID-19 cases indicated that 41.3% are due to hospital-related transmission [5]. As hemodialysis patients need admit to hospital for dialysis two to three times per week, most patients were immunocompromised due to uremia and physical proximity of patients during hemodialysis. These factors increase the risk of disease transmission and lead to hemodialysis patients being more susceptible to COVID-19 infection than the general population. Most hemodialysis patients are older age and have certain comorbidities, such as coronary disease, hypertension, diabetes, and lung disease, that are associated with unfavorable outcomes in patients with COVID-19[6]. Previous COVID-19 infection studies mostly focus on general population [7, 8]. Currently clinical information regarding the clinical features and outcome of COVID-19 in hemodialysis patients is lacking. So, according to describing clinical characteristics, laboratory finding, radiological characteristics, treatment, and outcomes of 16 hemodialysis patients confirmed to have COVID-19 infection, we aimed to provide an insight for the clinical assessment and management of hemodialysis patients with COVID-19.

Patients and methods

Study design and participants

For this retrospective, single-center study, we recruited hemodialysis patients with confirmed COVID-19 infection from Feb. 5th to Mar. 20th, 2020. in Wuhan Fourth Hospital, Tongji Medical College, Huazhong University of Science and Technology, Wuhan, China. Wuhan Fourth Hospital is one famous comprehensive hospital with long history of 150-years. During a major outbreak of COVID-19 in Wuhan, Chinese government arranged Wuhan Fourth Hospital as designated hospital for hemodialysis patients with COVID-19 infection. Hemodialysis patients with confirmed and suspected COVID-19 infection were admitted centrally to Wuhan Fourth Hospital. All enrolled hemodialysis patients with confirmed COVID-19 infection were diagnosed according to WHO interim guidance in this study [9]. The results were further compared with a control group of 62 nondialysis COVID-19 patients from the same hospital that were matched for sex and age. This study was approved by institutional review board (IRB) at Wuhan Fourth Hospital (IRB approval number: KY 2020-032-01). Informed consent was waived as part of a public health outbreak investigation.

Data Collection

Two doctors in our team collected and checked clinical information from electronic medical records in Wuhan Fourth Hospital. Patient information including epidemiology, demographics, medical history, laboratory findings, comorbidities, treatment regimens (antiviral, antibiotic, corticosteroid therapies, immune glucocorticoid therapy, and respiratory support), length of

hospital stay, and clinical outcomes were collected and analyzed. If data were missing from the medical records, we obtained data by communication with attending doctors or patients directly.

Definitions

The discharge criteria were defined as: body temperature has returned to normal for more than three days, the respiratory symptoms have improved significantly, and the chest CT imaging showed obvious inflammation absorption. Two consecutive nucleic acid tests for throat swabs were negative and the time interval was at least one day. Finally, after an evaluation by the expert team, a comprehensive evaluation was made whether the patient can be discharged.

Statistical analysis

In the descriptive statistical analysis, categorical variables were expressed as numerical values (%). Continuous variables were directly presented as median with interquartile ranges. All statistical analysis was performed using SPSS software (version 21.0).

Results

Clinical characteristics

A total of 16 hemodialysis patients with COVID-19 were included in this study. All patients were hospitalized. Clinical characteristics of 16 hemodialysis patients were showed in Table 1. The median age of all hemodialysis patients was 61 years (interquartile range 54-78 years), 8 of 16 patients were female. No case had exposure to Huanan seafood market that appeared to be the epicenter of COVID-19 infection. All patients had contact history of epidemic area and contact history of fever patients. 12 cases (75%) had comorbidities, with coronary disease, hypertension and diabetes being the most common. The most common initial symptoms at admission were cough (75%) and shortness of breath (50%), followed by fatigue (50%) and fever (43.75%). The median incubation period was 9 days (interquartile range 4.3-12 days), (Table 1). Compared with nondialysis patients, hemodialysis patients presented lower incidence of fever($p=0.001$). Although there is no statistical difference, hemodialysis patients had higher incidence of preadmission comorbidities and shortness of breath.

Radiological and laboratory findings

Abnormal chest CT scan were observed in 16 patients (100%) at admission, the chest CT imaging showed typical signs of viral infection in hemodialysis (Figure 1), such as bilateral patchy shadowing (100%) and ground-glass opacities (62.5%), (Table S1). But compared with nondialysis patients, hemodialysis patients presented higher incidence of pulmonary effusion ($p<0.001$), cord high density shadows ($p<0.001$), pleural thickening ($p=0.0046$), atelectasis ($p=0.0046$) and consolidation of lung($p=0.053$). Almost all hemodialysis patients had anemia

(15[93.75%] patients), hypoproteinemia (16[100%] patients), lymphopenia (16[100%] patients) and coagulopathy with elevated D-dimer (14[92.86%] patients) at admission. Infection-related biomarkers including procalcitonin and C-reactive protein, were also abnormal in almost all patients (Table S1). Compared with nondialysis patients, hemodialysis patients had a lower level of hemoglobin ($p<0.001$), white blood cell count ($p=0.015$), neutrophil ($p=0.016$), AST ($p=0.037$), ALT ($p<0.001$) and procalcitonin ($p<0.001$), and higher level of D-dimer($p<0.001$) and TT ($p<0.001$).

Treatment and outcomes

After hospital admission, all patients received treatment according to the Chinese Diagnosis and Treatment Protocol for Novel Coronavirus Pneumonia (6^{th} version) [10]. 15 of 16 patients received oxygen therapy in isolation. 14 of 16 patients received antiviral treatment, including Arbidol (0.2g three times daily, orally), Lopinavir and Ritonavir Tablets (0.5mg two times daily, orally), and Oseltamivir (75mg two times daily, orally) and Ribavirin (500 mg once per day, intravenously). Traditional Chinese medicines, such as Lianhuaqingwen capsules and Toujiequwen Keli, were also given. 14 (87.5%) patients were treated with antibiotic, including Amoxicillin clavulanate potassium, Levofloxacin, Moxifloxacin, Cephalosporin, Ceftriaxone, Cefoxitin, Cefoperazone sulbactam. 9 (56.25%) patients received a single antibiotic treatment and 5 (31.25%) patients received combination treatment. Two (12.5%) patients also received corticosteroids treatment, and 1(6.25%) patients received intravenous immunoglobulin therapy (Table S2). Compared with nondialysis patients, there was no difference in treatment between dialysis patients and general patients. Moreover, hemodialysis was performed according to the previous frequency in isolation

133 room designated for COVID-19 patients. At the end of follow-up (April 5, 2020), all clinical
134 outcomes of patients have been observed. The median hospitalization days was 21 days
135 (interquartile range, 15.5-30.25 days), 13 patients had recovered and been discharged from the
136 hospital, 3 patients were dead, mortality was 18.75%. Although there is no statistical difference,
137 hemodialysis patients showed higher mortality and prolonged hospital stay (p=0.427 and p=0.077).
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Discussion

This study represents the clinical characteristics and outcomes of hemodialysis patients infected with COVID-19. Currently, the research about hemodialysis patients with COVID-19 is scarce. This study is one of the first to report clinical characteristics and outcomes exhaustively.

We found most of the hemodialysis patients with COVID-19 were middle age and senile patients, 12 cases (75%) had comorbidities, including coronary disease, hypertension and diabetes. As most hemodialysis patients were immunocompromised due to uremia [11-13]. These factors may lead to longer hospital stay and higher mortality in hemodialysis patients than general population.

Hemodialysis patients presented similar clinical symptoms as general patients with COVID-19, including fever, cough, sore throat, shortness of breath, myalgia, headache, fatigue and diarrhoea [3, 7]. The length of the incubation period was almost the same, about 1-14 days. As previous study reported, only 18.7% patients had shortness of breath in nondialysis population [7], but the percent rate of shortness of breath was 50% in hemodialysis patients. We suggested it is attributable to several factors, firstly, most of hemodialysis patients (50%) had pulmonary effusion caused by hypoproteinemia due to chronic kidney disease and inadequate hemodialysis. Secondly, some hemodialysis patients had lung inflammation and pleural thickening for a long time due to long-term accumulation of fluid in the lungs. Moreover, hemodialysis patients had lower incidence of fever, this is probably related to the relatively suppressed immunity caused by uremia.

In this study, almost all hemodialysis patients had anemia, hypoproteinemia and lymphopenia coagulopathy with elevated D-dimer at admission. These factors increased the risk of unfavorable prognosis. Previous study revealed severe lymphopenia and elevated D-dimer were risk factors for

prognosis of patients with COVID-19[6]. But in hemodialysis patients, elevated D-dimer may be partly caused by uremia and hemodialysis. Hence, we could not simply assess D-dimer levels as risk factors for mortality in hemodialysis patients with COVID-19, as did in general population.

All hemodialysis patients had all typical signs of viral infection in chest CT imaging, including ground-glass opacities and bilateral patchy shadowing. But many maintenance hemodialysis patients had pulmonary effusion due to inadequate hemodialysis, and chronic lung inflammation caused by uremia and pulmonary effusion may lead to CT imaging features such as cord high density shadows, pleural thickening, atelectasis and pulmonary fibrosis. Moreover, Healthcare-associated pneumonia (HDAP) is the common infectious problems encountered in hemodialysis patients [14, 15]. Therefore, these CT features may make the diagnosis of COVID-19 infection more difficult in hemodialysis patients, compared with nondialysis population.

Respiratory syndrome coronavirus 2 (SARS-CoV-2), which cause the COVID-19 disease, belongs to the β-type coronavirus, which has an envelope, the particles are round or oval, often polymorphic, and the diameter is 60-140nm [16]. Current research showed SARS-CoV-2 has more than 79% homology with severe acute respiratory syndrome (SARS) coronavirus, and the S proteins of SARS-CoV-2 and SARS-CoV, have an sequence similarity of around 77%[17, 18], However, clinical studies demonstrated there were many differences between SARS-CoV-2 and SARS coronavirus, SARS-CoV-2 has higher infectivity and lower lethality compared with SARS coronavirus[7, 8, 19, 20]. A study about severe acute respiratory syndrome in dialysis patients showed dialysis patients had similar clinical features and mortality rates as the nondialysis patients, but dialysis patients tend to have less pronounced symptoms and had a much longer hospital stay

compared with nonuremic patients [21]. In our study, dialysis patients tend to have lower incidence of fever but higher incidence of shortness of breath and unfavorable clinical prognosis. We suggested it may be attributable to great differences in the pathogenic mechanisms of the two viruses, and further research is needed to demonstrate the differences.

The limitations of this study include the small number of patients from a single center, and a systematic and comprehensive study including large number of samples across multiple centres are needed to search COVID-19 infections in hemodialysis patients. Then as our hospital are designated hospital for only hemodialysis patients with COVID-19 infection, so we can only collect information of hemodialysis patients without COVID-19, and we cannot describe the epidemiology of COVID-19 infections in hemodialysis patients. However, this study provides some initial experiences about the characteristics of COVID-19 in hemodialysis patients.

In summary, we describe clinical characteristics and outcomes of hemodialysis patients with COVID-19 infection. Overall, hemodialysis patients were a high-risk group of COVID-19 infections, hemodialysis patients had similar clinical characteristics, with multiple comorbidities and worse physical condition, hemodialysis patients had prolonged hospital stay and unfavorable clinical prognosis. COVID-19 infection should be monitored intensively for hemodialysis patients.

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Author contributions

Dr. Luo had full access to all of the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis.

Study concept and design: C.A. Cao, Y.Y. Luo.

Acquisition, analysis, or interpretation of data: Y.Y. Luo, Z.F. Liu, J.L. Li, X. Peng.

Drafting of the manuscript: Y.Y. Luo, Z.F. Liu.

Critical revision of the manuscript for important intellectual content: C.A. Cao, X. Peng.

Statistical analysis: Y.Y. Luo.

Administrative, technical, or material support: J.L. Li, X. Peng.

Study supervision: C.A. Cao.

Data sharing Statement

With the permission of the corresponding author, we can provide participant data, statistical analysis.

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Conflict of interest

The authors have nothing to disclose.

Reference

1. Severe Outcomes Among Patients with Coronavirus Disease 2019 (COVID-19) - United States, February 12-March 16, 2020. MMWR Morb Mortal Wkly Rep 2020;69:343-6.
2. WHO. Coronavirus disease (COVID-2019) situation reports. Apr. 10, 2020. https://www.who.int/docs/default-source/coronaviruse/situation-reports/20200410-sitrep-81-covid-19.pdf?sfvrsn=ca96eb84_2 (accessed Apr. 11, 2020).
3. Wu Z, McGoogan JM. Characteristics of and Important Lessons From the Coronavirus Disease 2019 (COVID-19) Outbreak in China: Summary of a Report of 72 314 Cases From the Chinese Center for Disease Control and Prevention. JAMA 2020;Published online February 24, 2020. doi:10.1001/jama.2020.2648.
4. Chen N, Zhou M, Dong X, et al. Epidemiological and clinical characteristics of 99 cases of 2019 novel coronavirus pneumonia in Wuhan, China: a descriptive study. Lancet 2020;395:507-13.
5. Wang D, Hu B, Hu C, et al. Clinical Characteristics of 138 Hospitalized Patients With 2019 Novel Coronavirus–Infected Pneumonia in Wuhan, China. JAMA 2020;323:1061-9.
6. Zhou F, Yu T, Du R, et al. Clinical course and risk factors for mortality of adult inpatients with COVID-19 in Wuhan, China: a retrospective cohort study. Lancet 2020;395:1054-62.
7. Guan W-j, Ni Z-y, Hu Y, et al. Clinical Characteristics of Coronavirus Disease 2019 in China. N Engl J Med 2020.
8. Xu X-W, Wu X-X, Jiang X-G, et al. Clinical findings in a group of patients infected with the 2019 novel coronavirus (SARS-Cov-2) outside of Wuhan, China: retrospective case series. BMJ 2020;368:m606.
9. WHO. Clinical management of severe acute respiratory infection when Novel coronavirus (nCoV) infection is suspected: interim guidance. Jan 11, 2020. https://www.who.int/docs/default-source/coronaviruse/clinical-management-of-novel-cov.pdf (accessed Apr. 5, 2020).
10. Chinese diagnosis and treatment plan of COVID-19 patients (The sixth edition). http://www.nhc.gov.cn/yzygj/s7653p/202002/8334a8326dd94d329df351d7da8aefc2.shtml.
11. Syed-Ahmed M, Narayanan M. Immune Dysfunction and Risk of Infection in Chronic Kidney Disease. Adv Chronic Kidney Dis 2019;26:8-15.
12. Kim JU, Kim M, Kim S, et al. Dendritic Cell Dysfunction in Patients with End-stage Renal Disease. Immune Netw 2017;17:152-62.
13. MG B. Immune cell dysfunction and inflammation in end-stage renal disease. Nature reviews Nephrology 2013;9:255-65.
14. Carratala J, Garcia-Vidal C. What is healthcare-associated pneumonia and how is it managed? Curr Opin Infect Dis 2008;21:168-73.
15. Lee JH, Moon JC. Clinical characteristics of patients with hemodialysis-associated pneumonia compared to patients with non-hemodialysis community-onset pneumonia. Respir Med 2016;111:84-90.
16. Shang J, Ye G, Shi K, et al. Structural basis of receptor recognition by SARS-CoV-2. Nature 2020;Published online March 30, 2020. doi: 10.1038/s41586-020-2179-y. .

17. Yuan M, Wu NC, Zhu X, et al. A highly conserved cryptic epitope in the receptor-binding domains of SARS-CoV-2 and SARS-CoV. Science 2020;Published online April 03, 2020. DOI: 10.1126/science.abb7269:eabb7269.
18. Lu R, Zhao X, Li J, et al. Genomic characterisation and epidemiology of 2019 novel coronavirus: implications for virus origins and receptor binding. Lancet 2020;395:565-74.
19. Park M, Cook AR, Lim JT, et al. A Systematic Review of COVID-19 Epidemiology Based on Current Evidence. J Clin Med 2020;9:967.
20. Zhang J, Litvinova M, Wang W, et al. Evolving epidemiology and transmission dynamics of coronavirus disease 2019 outside Hubei province, China: a descriptive and modelling study. Lancet Infect Dis 2020;Published online April 2, 2020. doi: 10.1016/S1473-3099(20)30230-9.
21. BC K, CB L, CC S, et al. Severe acute respiratory syndrome in dialysis patients. J Am Soc Nephrol 2004;15:1883-8.

288 **Figure legend**

289 Figure 1: Chest CT imaging of four hemodialysis patients. Patient 4 (A), patient 9 (B), patient 13
290 (C), and patient 16 (D). The brightness of patients' lungs is diffusely decreased, presenting typical
291 signs of viral infection (large area of multiple ground-glass opacities or patchy shadow with an
292 uneven density), pulmonary effusion and cord high density shadows due to uremia and inadequate
293 hemodialysis.

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Table 1(on next page)

Table 1

Clinical characteristics of hemodialysis patients with COVID-19

1 **Table 1 Clinical characteristics of hemodialysis patients with COVID-19**

characteristics	No. (%)		p value
	Hemodialysis Patients	General Patients	
Age (years), median (IQR)	61(54-78)	62(50-70)	0.439
Male	8(50)	33(53.2)	0.755
Contact history of epidemic area	16(100)	62(100)	>0.99
Preadmission comorbidities	12(0.75)	38(0.61)	0.467
Hypertension	11(68.75)	19(30.65)	0.012
Diabetes	3(18.75)	11(17.74)	>0.99
Cardiovascular diseases	4(25)	4(6.45)	0.086
Cerebrovascular diseases	0(0)	2(3.23)	>0.99
Malignancy	1(6.25)	2(3.23)	>0.99
COPD	0(0)	2(6.45)	>0.99
Tuberculosis	0(0)	2(3.23)	>0.99
Pneumonia related manifestations			
Cough	12(75)	45(72.58)	0.699
shortness of breath	8(50)	19(33.87)	0.248
Fatigue	8(50)	42(67.74)	0.305
Fever	7(43.75)	54(87.10)	0.001
Diarrhoea	2(12.5)	11(17.74)	0.90
Myalgia	2(12.5)	23(37.10)	0.275
Headache	1(6.25)	2(3.22)	>0.99
Sore throat	1(6.25)	3(4.84)	>0.99
Incubation period (days)	9 (4.3-12)	8(5-12)	0.674

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Figure 1

Figure 1

Chest CT imaging of four hemodialysis patients

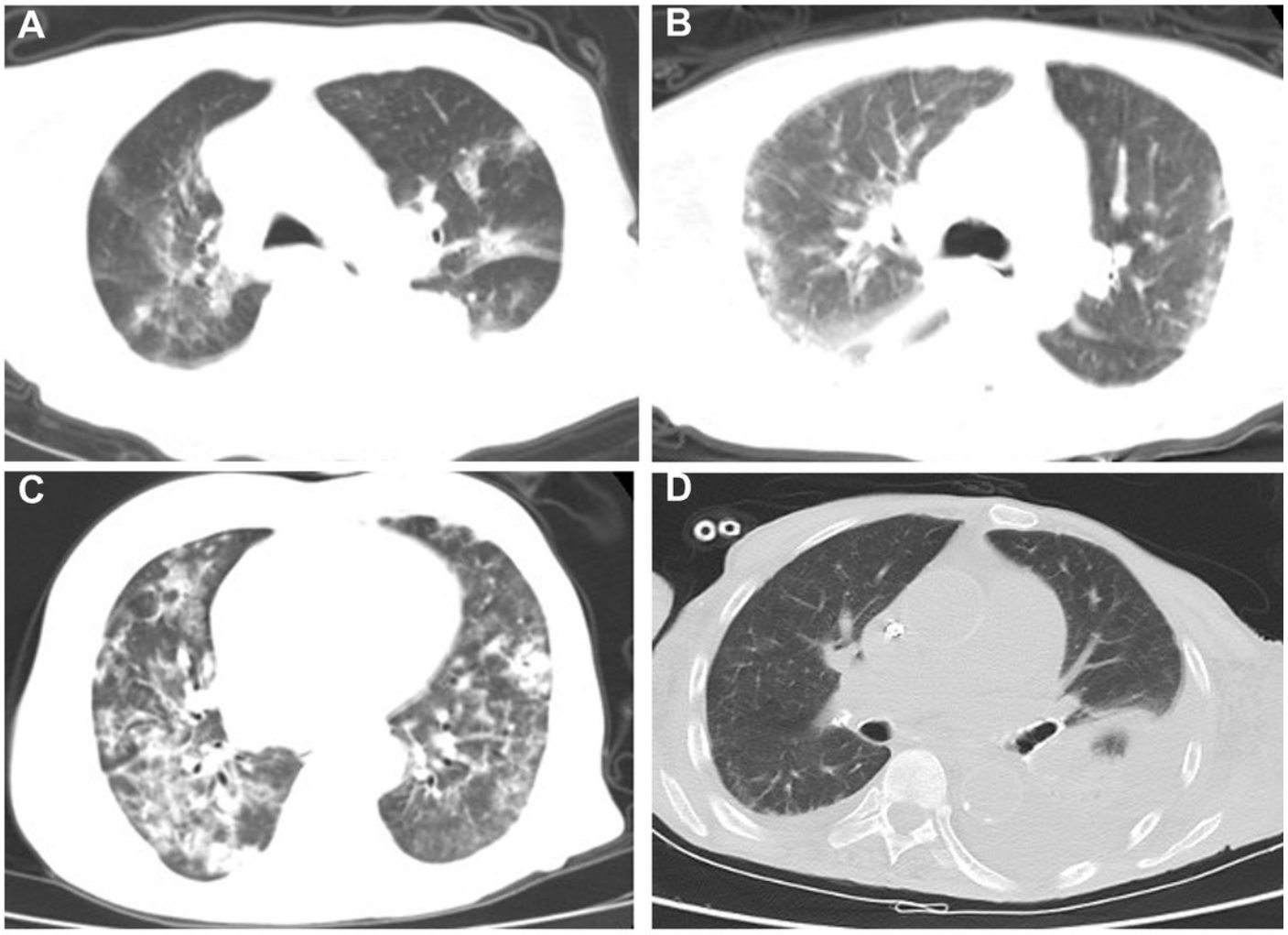

Table 2(on next page)

Table 2

Laboratory results of Hemodialysis patients with COVID-19

1 **Table 2 Laboratory results of Hemodialysis patients with COVID-19**

characteristics	No. (%)		p value
	Hemodialysis Patients	General Patients	
Admission radiologic findings (chest CT)			
Bilateral patchy shadowing	16(100)	58(93.5)	0.683
Ground-glass opacities	10(62.5)	47(75.8)	0.451
Pulmonary effusion	8(50)	2(3.23)	<0.001
Cord high density shadows	7(43.75)	4(6.45)	<0.001
Pleural thickening	4(25)	1(1.6)	0.0046
Atelectasis	4(25)	1(1.6)	0.0046
Consolidation of lung	2(12.5)	0(0)	0.053
Blood routine			
Hemoglobin (g/L)	91.5(79.25-102.5)	127.5(115-141.75)	<0.001
White blood cell count (×10^9/L)	4.29(3.56-6.69)	6.22(4.66-8.38)	0.015
Neutrophil(×10^9/L)	3.19(2.47-5.3)	5.18 (3.27-7.44)	0.016
Lymphocyte count (×10^9/L)	0.65(0.51-0.91)	0.74(0.40-1.17)	0.656
Coagulation function			
APTT	31.5(26.6-43.3)	35.5(32.13-38.32)	0.29
Prothrombin time (s)	12.2(11.05-14.13)	12.9(12.3-13.33)	0.133
TT	19.5(18.9-20.98)	15.7(14.7-16.5)	<0.001
D-dimer (mg/L)	1.84(0.88-4.55)	0.49(0.24-1.27)	<0.001
Blood biochemistry			
AST (U/L)	20(13-24)	25.5(17-42.25)	0.037
ALT (U/L)	10(6.25-13.5)	28(16-42.25)	<0.001
Serum creatinine (μmol/L)	1067.5(855.08-1392.23)	70.5(55.75-82.25)	<0.001

Infection-related biomarkers			
C-reactive protein (mg/L)	39.3(23.85-87.53)	44.74(20.73-74.20)	0.782
Procalcitonin (ng/mL)	0.85(0.44-2.79)	0.04(0.04-0.06)	<0.001

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Table 3(on next page)

Table 3

Treatment and clinical outcome of Hemodialysis patients with COVID-19

Table 3 Treatment and clinical outcome of Hemodialysis patients with COVID-19

characteristics	No. (%)		p value
	Hemodialysis Patients	General Patients	
Oxygen therapy	15(93.75)	52(83.9)	0.542
Mechanical ventilation	2(12.5)	6(9.68)	>0.99
Antibiotic treatment	14(87.5)	47(75.8)	0.503
Antiviral treatment	14(87.5)	60(96.8)	0.388
Traditional chinese medicine	14(87.5)	56(90.3)	1
Glucocorticoids	2(12.5)	15(24.2)	0.503
Intravenous immunoglobulin therapy	1(6.25)	9(14.5)	0.644
Length of stay (d)	21 (15.5-30.25)	14 (11-20)	0.077
Outcomes（death	3(18.75)	5(8.06)	0.427