



Clinical and hematological characteristics of 300 COVID-19 patients in Erbil, Kurdistan Region, Iraq

International Journal of
Immunopathology and Pharmacology
Volume 36: 1–9
© The Author(s) 2022
Article reuse guidelines:
sagepub.com/journals-permissions
DOI: 10.1177/03946320221085465
journals.sagepub.com/home/iji


Rundk Ahmad Hwaiz^{1,2} , Sahar Mohammed Zaki Abdullah³, Salah Tofik Jalal Balaky^{2,3}, Katan Sabir Ali³, Mohammed Yousif Merza^{2,4,5}, Shakhawan Assad Khailani⁶ and Nazar Pauls Shabila⁷

Abstract

Background: COVID-19 primarily presents as a respiratory tract infection, but studies indicate that it could be considered a systemic disease that can spread to affect multiple organ systems, including respiratory, cardiovascular, gastrointestinal, hematopoietic, neurological, and immune systems.

Objective: To describe and analyze the clinical and hematological characteristics of 300 hospitalized COVID-19 patients in Erbil, Kurdistan.

Methods: This retrospective study included 300 patients of any age admitted to hospital due to confirmed COVID-19 between September 2020 and February 2021. Cases were diagnosed by reverse transcriptase polymerase chain reaction assays of nasopharyngeal swab specimens.

Results: The highest proportion of patients were aged 21–40 years. The most common symptoms among the patients were myalgia (66.7%), fatigue (62.3%), headache (50.7%), and chest pain (52.7%). Differences in hematological and biochemical parameters were observed between deceased and recovered patients. Only the mid-range absolute count percentage (MID%) was significantly higher in the recovered patients than in the deceased ones (6.41% vs. 4.48, $p = 0.019$). Death was significantly higher among older patients (>40 years) than younger ones (≤ 40 years) (6.8% vs. 1.3%, $p = 0.015$), diabetic than non-diabetic (10.8% vs. 3%, $p = 0.047$), and those having chronic diseases than those without chronic diseases (10.6% vs. 2.1%, $p = 0.006$).

Conclusions: Different hematological and biochemical parameter findings were observed among the COVID-19 patients. Low MID%, older age, and presence of diabetes mellitus and chronic disease were significantly associated with death among COVID-19 patients.

¹Department of Clinical Biochemistry, College of Health Sciences, Hawler Medical University, Erbil, Iraq

²Medical Analysis Department, Tishk International University, Erbil, Iraq

³Department of Medical Microbiology, College of Health Sciences, Hawler Medical University, Erbil, Iraq

⁴Department of Clinical Analysis, College of Pharmacy, Hawler Medical University, Erbil, Iraq

⁵Medical Biochemical Analysis Department, College of Health Technology, Cihan University, Erbil, Iraq

⁶Emirates Hospital, Corona Center, Ministry of Health, Erbil, Iraq

⁷Department of Community Medicine, College of Medicine, Hawler Medical University, Erbil, Iraq

Corresponding author:

Rundk Ahmad Hwaiz, Department of Clinical Biochemistry, College of Health Sciences, Hawler Medical University, Erbil, Kurdistan 100M street Erbil 00964, Iraq.

Email: rundk.hwaiz@hmu.edu.krd



Creative Commons Non Commercial CC BY-NC: This article is distributed under the terms of the Creative Commons Attribution-NonCommercial 4.0 License (<https://creativecommons.org/licenses/by-nc/4.0/>) which permits non-commercial use, reproduction and distribution of the work without further permission provided the original work is attributed as specified on the SAGE and Open Access pages (<https://us.sagepub.com/en-us/nam/open-access-at-sage>).

Keywords

COVID-19, hematological characteristics, Kurdistan Region, retrospective study

Date revised: 31 August 2021; accepted: 17 February 2022

Introduction

The ongoing COVID-19 pandemic caused by the novel coronavirus severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) follows in the wake of severe acute respiratory syndrome (SARS) and Middle East respiratory syndrome (MERS), all of which were significant public health threats.¹ SARS-CoV-2 is a type of RNA virus that primarily causes respiratory system infection. Compared with SARS and MERS, COVID-19 displays several significant differences as well as similarities. Fundamentally, COVID-19 is not as “deadly as other coronaviruses including MERS and SARS,” the latter of which have much higher fatality rates (40% and 10%, respectively), compared to COVID-19’s 5.6%.² The current SARS CoV-2 genome shares 79% in common with SARS-CoV, but it is more easily transmissible.³

The main COVID-19 pathogen transmission route is thought to be through respiratory droplets, although viral particles via fecal contact have also been reported.⁴ It invades human cells by binding to the angiotensin-converting enzyme2 (ACE2) receptor. The primary manifestation of COVID-19 is a respiratory tract infection, but studies indicate that it could be considered a systemic disease that can spread to affect multiple organ systems, including the respiratory, gastrointestinal, cardiovascular, neurological, immune, and hematopoietic systems.⁵

The disease has an incubation period of about 5 days, and the period from the starting symptoms to the death varies from 6 to 41 days, depending on the patient’s immune system and age.¹ The most prevalent symptoms are fever, cough, and fatigue. Other symptoms include dyspnea, headache, sputum production, hemoptysis, diarrhea, and lymphopenia,¹ and there is radiographic evidence of pneumonia.⁶

The immune system is the primary venue for fighting against and controlling infectious disease, but viral infection can also lead to immunopathogenesis, with the resulting immune response becoming out of control.⁷ The human immune hyperinflammatory response and the reasonable effects of severe acute respiratory syndrome on multiple organs through ACE2 have been associated with disease complications.⁸ The main factors determining the disease severity are primarily related to host factors, such as age and lymphocytopenia.⁹ According to the World Health Organization (WHO) Situation Report on COVID-19 (<https://covid19.who.int/>), case and death incidences have continued to decrease, with over 3 million new

weekly cases and over 73,000 new deaths, which mean a 15% and an 8% decreases, respectively, compared to the previous week. In the Iraqi Kurdistan Region, the number of cases has decreased to 362, with 17 death incidences as of November 2021 (<https://gov.krd/coronavirus-en/dashboard/>).

There are few studies available on the clinical characteristics of COVID-19 patients and their outcomes, including mortality rate, especially for West Asia and the Kurdistan Region. This study describes and analyzes the clinical and hematological characteristics of recorded data from files of 300 hospitalized COVID-19 patients in Erbil, Kurdistan. This effort will assist in making progress in our understanding of the complications of the disease and implementing better control strategies and preventive measures for the treatment of this patient population.

Methods

Sampling

This retrospective study included 300 patients with confirmed COVID-19 diagnosis consecutively admitted to three designated COVID-19 hospitals in Erbil (Rizgari, Peshmarga, and Emirate Hospitals) from 15 September 2020, to 2 February 2021. Most COVID-19 cases in Erbil City were admitted to these hospitals. The cases were confirmed by reverse-transcriptase polymerase-chain-reaction (RT-PCR) assays of nasopharyngeal swab specimens at Erbil Central Laboratory. Patients of any age admitted to these hospitals with proven COVID-19 infection were enrolled in this study, and blood samples were collected. As the hospitals are specialized only for COVID-19 patients, no patients with other medical issues were admitted. Since all admitted COVID-19 patients with adequate information were enrolled in the study, there was no need for sample size calculation and random sample selection.

Intervention

The COVID-19 patients were given the treatment according to the WHO guidelines, depending on the status of the patients, including standard analgesics like paracetamol and antivirals (e.g., remdesivir and favipiravir). Patients who experienced a bacterial co-infection were treated with broad-spectrum antibiotics (e.g., meropenem and levofloxacin). Patients also received anti-inflammatory agents

(e.g., dexamethasone), anticoagulants (e.g., clexane), and supportive treatments (e.g., vitamin C, vitamin D, and zinc). In severe cases, oxygen was also supplied, and critical cases were admitted to the intensive care unit, particularly for urgent care upon admission.

Inclusion and exclusion criteria

The patients admitted to these hospitals included moderate and severe cases of COVID-19. Blood samples were taken from COVID-19 patients on admission. All participants had PCR-confirmed COVID-19 diagnosis. Patients missing some information in their records were excluded.

Questionnaire

A three-part questionnaire developed by the researchers based on related studies was used to collect demographic and clinical information from the patients ([Supplementary File 1](#)). The first part included questions about the socio-demographic characteristics of the patients, including age, gender, marital status, and area of residence. The second part of the questionnaire included questions about the past medical and clinical characteristics, including blood group, height and weight, history of chronic diseases, smoking status, alcohol drinking, and presence of vitamin D deficiency. The third part concerned COVID-19-related characteristics such as symptoms, results of laboratory investigations, and outcomes. The questionnaire was pilot tested and validated for its contents before collecting data.

Ethical consideration

The Research Ethics Committee of the College of Health Sciences, Hawler Medical University, approved the study protocol (Reference: HCB 66/15/04/2020). The Research Ethics Committee waived the requirement for obtaining written informed consent from the participants, and recommended obtaining verbal informed consent due to the special situation of hospitalized and isolated COVID-19 patients, since anonymous patient data was used. Thus, verbal informed consent was obtained from all subjects or the legally authorized representatives of deceased patients before the study. The anonymity of the patients was ensured.

Statistical analyses

IBM SPSS Statistics version 22 was used for data analyses. Student t-test was used to compare two means for the normally distributed data. The Chi square test of association was used to compare proportions, and Fisher's exact test was used if the expected count of > 20% of the cells was less than 5. A p value of ≤ 0.05 was

regarded as statistically significant. Multivariate analysis was also used to control for possible confounding factors. Baseline variables were considered for inclusion in the multivariate model based on a significant univariate Wald test (p value < 0.25).

Results

The mean \pm SD age of the 300 patients was 40.7 ± 15.9 years (range 7 to 80 years). The largest cohorts of patients were: aged 21–40 years (41.3%) and 41–60 years (39.7%); male (58%); married (78%); and overweight (47%). Details of patient characteristics are shown in [Table 1](#).

Of the 300 patients, 287 (95.7%) had a history of contact with COVID-19 patients. The most common symptoms among the patients were myalgia (66.7%), fatigue (62.3%), headache (50.7%), chest pain (52.7%), shortness of breath (47%), chills (44%), and cough (42.7%). Details of the prevalence of symptoms among the patients are shown in [Table 2](#).

Around 16% of the patients had hypertension, and 12.3% had diabetes mellitus. Of 330 patients, 12 (4%) died. A total of 18 patients (6%) had severe disease (died or had organ failure). Details of the prevalence of chronic diseases among the patients and other clinical characteristics and disease outcomes are shown in [Table 3](#).

The hematological and biochemical parameters of the patients and the difference between these parameters in deceased and recovered patients are shown in [Table 4](#). Student t-test was used to compare two independent sample means, finding that only mid-range absolute count (MID%) was significantly higher in recovered patients than in deceased patients (6.41% vs. 4.48, $p = 0.019$). MID generally includes monocytes, eosinophils, and basophils.¹⁰

The univariate analysis showed that death was significantly higher among older patients (>40 years) than among younger ones (≤ 40 years) (6.8% vs. 1.3%, $p = 0.015$), diabetic than non-diabetic (10.8% vs. 3%, $p = 0.047$), and those having chronic diseases than those without chronic diseases (10.6% vs. 2.1%, $p = 0.006$). The association of different demographic and clinical characteristics with the outcome of the disease through univariate analysis is shown in [Table 5](#).

[Table 6](#) shows the multivariate analysis. Only male gender was an independent factor associated with death in COVID-19 patients (OR = 5.65, 95% CI 1.01–31.63). The other factors showed a high magnitude of effect (OR), particularly age and presence of diabetes mellitus and chronic diseases, but have not reached a statistically significant association level. The latter is most probably due to having a small number of patients with the disease outcome in our sample, that is, deceased cases.

Table 1. Participant characteristics.

Characteristic	Frequency	Percent
Age group		
≤20	29	9.7
21-40	124	41.3
41-60	119	39.7
≥61	28	9.3
Gender		
Male	174	58.0
Female	126	42.0
Residence		
City center	267	89.0
Suburbs	33	11.0
Marital status		
Single	66	22.0
Married	234	78.0
BMI		
Underweight	26	8.7
Normal	47	15.7
Overweight	141	47.0
Obese	86	28.7
Blood group		
O	133	44.3
B	36	12
A	76	25.3
AB	55	18.3

Discussion

This study described the risk factors and clinical features among 300 confirmed COVID-19 patients. Of the enrolled participants, 4% died; this is considered a relatively low death rate for hospitalized COVID-19 patients, as other studies have shown much higher death rates among this group.^{11,12} The low death rate in our study is likely attributable to the Ministry of Health's policy of admitting *all* PCR-confirmed COVID-19 cases to the hospital, independent of symptom severity.

The association of different demographic and clinical characteristics was described with the outcome of the disease. Death was significantly higher among older patients (>40 years) than among younger ones (≤40 years), diabetic than non-diabetic, and those with chronic diseases than those without chronic diseases. This agrees with studies that found an association between older age and high mortality in COVID-19 patients.^{1,13} Moreover, our results showed significantly higher death among male COVID-19 patients than among their female counterparts, which could be due to hormonal differences. Testosterone is known to suppress the immune system, while estrogen can promote it; this could be why women have a stronger immune response against bacteria and viruses.¹⁴⁻¹⁶ Our findings agree with similar previous studies.^{13,17}

Table 2. Prevalence of COVID-19 symptoms.

Variables	Frequency	Percent
Fever	110	36.7
Headache	152	50.7
Rigor	132	44.0
Cough	128	42.7
Sore throat	71	23.7
Myalgia	200	66.7
Fatigue	187	62.3
Sneezing	11	3.7
Sputum	23	7.7
Shortness of breath	141	47.0
Nasal discharge	9	3.0
Chest pain	158	52.7
Hemoptysis	6	2.0
Vomiting	0	0.0
Diarrhea	8	2.7

Table 3. Prevalence of chronic diseases, clinical characteristics, and COVID-19 outcomes.

Variables	Frequency	Percent
Diabetes mellitus	37	12.3
Hypertension	49	16.3
Anemia	16	5.3
Cardiovascular disease	11	3.7
Vitamin D deficiency	136	45.3
Smoking	57	19.0
Alcohol	6	2.0
Chronic disease	66	22.0
Pregnancy	1	0.3
Complications	10	3.3
Death	12	4.0
Severe (death or complications)	18	6.0

Our results also indicate that the death rate was significantly higher among people with diabetes and chronic diseases. Similarly, a previous study found that hypertension and other cardiovascular diseases were more frequent among fatal COVID-19 cases.¹⁸ Diabetes mellitus and obesity are important risk factors for developing severe COVID-19 illness.⁵ Also, it has been reported that acute respiratory distress is greatly associated with older age (>65 years old) and comorbidities such as diabetes mellitus and hypertension.⁸ While the precise nature and correlation of COVID-19 risk factors remain unclear, a significant proportion of participants had underlying conditions commonly associated with more serious symptoms of SARS viruses. More hospitalized SARS pneumonia patients had chronic medical illnesses, namely cardiovascular and cerebrovascular diseases.¹⁹ It has been observed that

Table 4. Hematological and biochemical parameters and differences between deceased and recovered patients.

Variable	Normal range	Total		Recovered		Died		p value*
		Mean	SD	Mean	SD	Mean	SD	
Lymphocytes	0.9–5.0 × 10 ⁹ /L	1.54	1.20	1.54	1.21	1.35	0.86	0.584
MID	0.1–1.5 × 10 ⁹ /L	0.49	0.46	0.49	0.47	0.39	0.22	0.471
MID%	2.0–15.0%	6.33	2.80	6.41	2.80	4.48	2.15	0.019
Granulocytes	1.2–8.0 × 10 ⁹ /L	7.27	5.12	7.16	5.07	9.92	5.81	0.067
Hemoglobin	11.5–16.5 g/dl	14.01	1.81	13.97	1.82	14.76	1.18	0.142
MCH	25.0–35.0 pg	28.53	2.45	28.52	2.49	28.89	1.31	0.603
MCHC	31.0–38.0 g/dl	33.63	1.56	33.63	1.59	33.63	0.55	0.993
MCV	75.0–100.0 fl	84.74	7.57	84.70	7.70	85.80	3.24	0.623
Hematocrit	35.0–55.0%	41.60	6.08	41.51	6.16	43.82	3.16	0.198
RDW%	11%–16%	12.08	1.26	12.11	1.27	11.43	0.66	0.067
Thrombocyte	130–400 × 10 ⁹ /L	235.70	105.85	235.70	105.81	235.75	111.41	0.999
MPV	6.5–11.0 fl	9.05	0.82	9.06	0.83	8.90	0.56	0.508
PDW %	0.1%–99.9%	28.20	16.32	28.07	16.29	31.36	17.45	0.495
P-LC%	0.1%–99.9%	22.05	7.21	22.08	7.31	21.36	4.24	0.735
GOT	5.0–37.0 U/L	29.19	21.29	28.79	21.09	38.80	24.63	0.111
GPT	5.0–40.0 U/L	28.65	21.39	28.21	21.41	39.19	18.81	0.081
Total bilirubin	0.2–1.0 mg/dl	1.29	0.95	1.27	0.94	1.68	1.10	0.146
ALP	35.0–140.0 U/L	77.33	54.35	77.21	54.74	80.13	45.99	0.856
CRP	0.0–1.0 mg/dl	1.51	2.70	1.52	2.75	1.45	1.24	0.933
Blood urea	15.0–45.0 mg/dl	24.73	8.68	24.67	8.73	26.12	7.41	0.573
Serum creatinine	0.5–1.1 mg/dl	0.40	0.20	0.41	0.20	0.30	0.12	0.080

*Student t-test for independent samples was used for p value calculation. p value represents the comparison between the mean value of each parameter in recovered and mortality cases.

Abbreviations: MID: mid-range absolute count (generally including monocytes, eosinophils, and basophils), ALP: alkaline phosphatase, CRP: C-reactive protein, GOT: glutamic oxaloacetic transaminase, GPT: glutamic pyruvic transaminase, MCH: mean corpuscular hemoglobin, MCHC: mean corpuscular hemoglobin concentration, MCV: mean corpuscular volume, MPV: mean platelet volume, PDW: platelet distribution width, P-LC: platelet large count, RDW: red blood cell distribution width.

the elderly and those with underlying disorders such as diabetes, hypertension, cardiovascular disease, and chronic obstructive pulmonary disease are more liable to acute respiratory distress syndrome and even death.^{7,20}

Our study found that the death rate was higher among the AB group, followed by the O blood group than the type A and B blood groups. Our data are consistent with results that found that type A had a lower risk of death than types AB and O. Type B is the only type with an inconsistent effect on death. On the other hand, type B increased the risk of intubation and decreased risk of death compared to type O, related to the protective effect of Rh negative blood groups on COVID-19 infection and death.

In this study, the most common symptoms among the patients were myalgia (66.7%), fatigue (62.3%), headache (50.7%), chest pain (52.7%), shortness of breath (47%), chills (44%), and cough (42.7%), with low rates of vomiting and diarrhea. In most studies, fever was the most common symptom. According to Guan et al. fever (88.7%), cough (67.8%), and fatigue (38.1%) were the most common clinical manifestations in 1099 laboratory-confirmed COVID-19 cases, followed by sputum (33.7%), dyspnea

(18.7%), sore throat (13.9%), and headache (13.6%). Only a few COVID-19 patients developed gastrointestinal symptoms, such as diarrhea (3.8%) and vomiting (5.0%).²¹ While fever had been the dominant symptom in most studies, some severely ill patients may have moderate, low, or even no significant fever. This is in line with our results which revealed that fever is not a common presentation.²² Huang et al. also reported that the most common initial symptoms included fever (98%), cough (76%), dyspnea (55%), and myalgia (44%).²³ A study done by Wang et al. found that fever (99%), fatigue (70%), and dry cough (59%) were the common presenting symptoms. However, two patients had no signs of fever at the initial stage of the illness.²⁴

One of the most important findings in this study was the change in MID levels and percentages. MID% was significantly higher in recovered patients than deceased patients (6.41% vs. 4.48, $p = 0.019$) (Table 4). We did not have detailed data for the MID% components separately to determine which component was primarily responsible for the high level of MID%. Compared to other studies, Yan *et al.* found higher eosinophils count in survivors than

Table 5. Association of different demographic and clinical characteristics with death outcome through univariate analysis.

Variable	Recovered		Died		p value
	No.	%	No.	%	
Age group					
≤40	151	98.7	2	1.3	0.015*
>40	137	93.2	10	6.8	
Gender					
Male	164	94.3	10	5.7	0.070*
Female	124	98.4	2	1.6	
Marital status					
Single	66	100.0	0	0.0	0.075**
Married	222	94.9	12	5.1	
Residence					
Center	257	96.3	10	3.7	0.628**
Surrounding	31	93.9	2	6.1	
BMI					
Under normal	72	98.6	1	1.4	0.305**
Overweight/obese	216	95.2	11	4.8	
Diabetes mellitus					
No	255	97.0	8	3.0	0.047**
Yes	33	89.2	4	10.8	
Hypertension					
No	242	96.4	9	3.6	0.422**
Yes	46	93.9	3	6.1	
Anemia					
No	272	95.8	12	4.2	1.000**
Yes	16	100.0	0	0.0	
Cardiovascular disease					
No	277	95.8	12	4.2	1.000**
Yes	11	100.0	0	0.0	
Vitamin D deficiency					
No	158	96.3	6	3.7	0.740*
Yes	130	95.6	6	4.4	
Smoking					
No	235	96.7	8	3.3	0.251**
Yes	53	93.0	4	7.0	
Alcohol					
No	282	95.9	12	4.1	1.000**
Yes	6	100.0	0	0.0	
Blood group					
O	130	97.7	3	2.3	0.960*
B	34	94.4	2	5.6	
A	74	97.4	2	2.6	
AB	50	90.9	5	9.1	
Chronic disease					
No	229	97.9	5	2.1	0.006**
Yes	59	89.4	7	10.6	

*Chi square test was used to obtain the p value.

**Fisher's exact test was used to obtain the p value.

Table 6. Multivariate analysis showing factors independently associated with death outcome.

Variable	B	S.E.	Sig.	OR	95% CI for OR	
					Lower	Upper
Age (>40 years)	1.141	0.825	0.167	3.13	0.62	15.76
Gender (male)	1.732	0.878	0.049	5.65	1.01	31.63
BMI (overweight/obese)	0.518	1.083	0.633	1.68	0.20	14.02
Diabetes mellitus	0.963	0.803	0.230	2.62	0.54	12.63
Smoking	0.078	0.662	0.906	1.08	0.30	3.96
Chronic disease	1.052	0.721	0.144	2.86	0.70	11.76

non-survivors.²⁵ Furthermore, the significant increase in monocytes might play a significant role in the recovery of patients with mild COVID-19. Having a large number of lymphocytes and monocytes can benefit in fighting against COVID-19, which may be instrumental in the low COVID-19 morbidity among young children.²³ Having such significant association between MID% and death in COVID-19 patients, especially if we know the primary component of MID% responsible for such association, might suggest that this parameter might be helpful to monitor patient status and assess the severity of symptoms during hospital admission. However, more studies with larger samples, a larger number of patients with the outcome of death, and details of the components of MID% are needed to confirm this significant association.

Our data showed a clear decrease in lymphocyte count in both recovered and deceased patients (Table 4). A previous study that included 1099 COVID-19 cases in China showed that most patients had lymphocytopenia (83.2%), while 36.2% had thrombocytopenia, and 33.7% had leukopenia. Such hematological abnormalities were more evident in severe than in non-severe cases.²⁶

Systemic increase of inflammatory mediators and cytokines is characterized as a “cytokine storm,” with prominent and significant lymphopenia.²⁷ Although several factors may lead to COVID-19-associated lymphopenia, lymphocytes might express the ACE2 receptor on their surface, and COVID-19 might infect those cells directly, leading to their lysis.²⁷ Moreover, the cytokine storm is marked by a considerable increase in the levels of interleukins (mostly IL-6, IL-2, IL-7, interferon- γ inducible protein, granulocyte colony stimulating factor, and tumor necrosis factor (TNF)-alpha), which might stimulate lymphocyte apoptosis.^{17,28–30}

Previous studies reported that the most common hematological findings include lymphocytopenia, eosinopenia, neutrophilia, and mild thrombocytopenia, followed by thrombocytosis; furthermore, the leukocyte count may be normal, reduced, or increased.^{26,31,32}

In this study, there was a mild increase in WBC count in patients with severe disease, and a clinically significant

increase in WBC count among patients who died. Therefore, a significant increase in WBCs in patients with severe disease may signify clinical worsening and an increased risk of a poor outcome. He et al. demonstrated the effect of SARS coronavirus infection on peripheral blood lymphocytes and their subsets, and reported that the increase in WBCs is related to elevated neutrophils while decreasing trends were seen in lymphocytes, monocytes, and eosinophils. A decrease in CD4 and CD8 was reported in patients with severe disease.³³ It is thought that lymphocytes are essential to eliminating virally infected cells in the SARS virus. In COVID-19, it is thought that survival is based on the ability to replenish lymphocytes that are killed by the virus. Thus, the lymphocyte count, especially CD4, may be considered a clinical predictor of COVID-19 severity and prognosis.³⁴

Limitations

In this study, we did not calculate the sample size or the power calculation, nor was a random representative sample used, as we included all patients with adequate information admitted to the main COVID-19 hospitals in Erbil city. Another limitation includes having a relatively small sample size and having a small number of patients with the outcome of the disease, that is, death. All these factors affect the generalizability of the findings and might provide bias and incorrect estimation of the magnitude and significance of the association of the main variables with the outcome of the disease. In addition, we could not analyze the effect of different COVID-19 treatments on clinical outcomes and the main changes after the used treatments. Our data also lacked the details of the deceased cases, such as clinical characteristics, clinical course, and treatment. This study also lacked long-term follow-up on recovered cases. The availability of the above important information would have helped us better understand the determinants of COVID-19 severity and associated death and could have helped future management of cases. The lack of important information about patients, such as race and ethnicity, was another limitation of this study.

Conclusion and recommendations

Different hematological and biochemical parameter findings were observed among the COVID-19 patients. Low MID%, older age, and presence of diabetes mellitus, and chronic disease were significantly associated with death among COVID-19 patients. We recommend studies on a larger number of cases to confirm our preliminary findings and analyze the aspects that our study has not addressed.

Acknowledgments

We would like to thank the Ministry of Health, Kurdistan Region of Iraq. Special thanks to the Corona Center (Emirates Hospital/ Erbil) staff, Mr. Mustafa Mohammed, Chemist Bahjat Rahman Hamad Ali, and Laboratory Assistant Adil Abdullah Omer for their continuous facilities and help.

Declaration of conflicting interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Ethics approval

The Research Ethics Committee of the College of Health Sciences, Hawler Medical University, approved the study protocol (Reference: HCB 66/15/04/2020). The Research Ethics Committee waived the requirement for obtaining written informed consent from the participants, and recommended obtaining verbal informed consent due to the special situation of hospitalized and isolated COVID-19 patients, since anonymous patient data was used. Thus, verbal informed consent was obtained from all subjects or the legally authorized representatives of deceased patients before the study. The anonymity of the patients was ensured.

Funding

The author(s) received no financial support for the research, authorship, and/or publication of this article.

Authorship

All authors contributed equally. All authors have read and approved the final version of the manuscript.

Informed consent

Verbal informed consent was obtained from all subjects before the study. Verbal informed consent was also obtained from legally authorized representatives of deceased patients before the study.

ORCID iD

Rundk Ahmad Hwaiz  <https://orcid.org/0000-0002-2743-0807>

Supplemental material

Supplemental material for this article is available online.

References

1. Rothan HA and Byrareddy SN (2020) The epidemiology and pathogenesis of coronavirus disease (COVID-19) outbreak. *Journal of Autoimmunity* 109: 102433.
2. Baud D, Qi X, Nielsen-Saines K, et al. (2020) Real estimates of mortality following COVID-19 infection. *The Lancet Infectious diseases* 20(7): 773.
3. Wang H, Li X, Li T, et al. (2020) The genetic sequence, origin, and diagnosis of SARS-CoV-2. *European Journal of Clinical Microbiology & Infectious Diseases: Official Publication of the European Society of Clinical Microbiology* 39(9): 1629–1635.
4. Wilder-Smith A and Freedman DO (2020) Isolation, quarantine, social distancing and community containment: pivotal role for old-style public health measures in the novel coronavirus (2019-nCoV) outbreak. *Journal of Travel Medicine* 27(2): taaa020
5. Gupta A, Madhavan MV, Sehgal K, et al. (2020) Extrapulmonary manifestations of COVID-19. *Nature Medicine* 26(7): 1017–1032.
6. Lei J, Li J, Li X, et al. (2020) CT Imaging of the 2019 Novel Coronavirus (2019-nCoV) Pneumonia. *Radiology* 295(1): 18.
7. Guo YR, Cao QD, Hong ZS, et al. (2020) The origin, transmission and clinical therapies on coronavirus disease 2019 (COVID-19) outbreak - an update on the status. *Military Medical Research* 7(1): 11.
8. Zaim S, Chong JH, Sankaranarayanan V, et al. (2020) COVID-19 and multiorgan response. *Current Problems in Cardiology* 45(8): 100618.
9. Zhang X, Tan Y, Ling Y, et al. (2020) Viral and host factors related to the clinical outcome of COVID-19. *Nature* 583(7816): 437–440.
10. Khoo TL, Xiros N, Guan F, et al. (2013) Performance evaluation of the Abbott CELL-DYN Emerald for use as a bench-top analyzer in a research setting. *International Journal of Laboratory Hematology* 35(4): 447–456.
11. Challen R, Brooks-Pollock E, Read JM, et al. (2021) Risk of mortality in patients infected with SARS-CoV-2 variant of concern 202012/1: matched cohort study. *BMJ* 372: n579.
12. Macedo A, Goncalves N and Febra C (2021) COVID-19 fatality rates in hospitalized patients: systematic review and meta-analysis. *Annals of Epidemiology* 57: 14–21.
13. Jin JM, Bai P, He W, et al. (2020) Gender differences in patients with COVID-19: focus on severity and mortality. *Front Public Health* 8: 152.
14. Klein SL and Flanagan KL (2016) Sex differences in immune responses. *Nature Reviews Immunology* 16(10): 626–638.
15. Cai KC, van Mil S, Murray E, et al. (2016) Age and sex differences in immune response following LPS treatment in mice. *Brain, Behavior, and Immunity* 58: 327–337.
16. Fischer J, Jung N, Robinson N, et al. (2015) Sex differences in immune responses to infectious diseases. *Infection* 43(4): 399–403.

17. Hwaiz R, Merza M, Hamad B, et al. (2021) Evaluation of hepatic enzymes activities in COVID-19 patients. *International Immunopharmacology* 97: 107701.
18. Chen T, Wu D, Chen H, et al. (2020) Clinical characteristics of 113 deceased patients with coronavirus disease 2019: retrospective study. *BMJ* 368: m1091.
19. Lai CC, Liu YH, Wang CY, et al. (2020) Asymptomatic carrier state, acute respiratory disease, and pneumonia due to severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2): facts and myths. *Journal of Microbiology, Immunology, and Infection = Wei mian yu gan ran za zhi* 53(3): 404–412.
20. Williamson EJ, Walker AJ, Bhaskaran K, et al. (2020) Factors associated with COVID-19-related death using OpenSAFELY. *Nature* 584(7821): 430–436.
21. Gao QY, Chen YX and Fang JY (2020) 2019 Novel coronavirus infection and gastrointestinal tract. *Journal of Digestive Diseases* 21(3): 125–126.
22. Chen N, Zhou M, Dong X, et al. (2020) Epidemiological and clinical characteristics of 99 cases of 2019 novel coronavirus pneumonia in Wuhan, China: a descriptive study. *Lancet* 395(10223): 507–513.
23. He B, Wang J, Wang Y, et al. (2020) The metabolic changes and immune profiles in patients with COVID-19. *Frontiers in Immunology* 11: 2075.
24. Song WJ, Hui CKM, Hull JH, et al. (2021) Confronting COVID-19-associated cough and the post-COVID syndrome: role of viral neurotropism, neuroinflammation, and neuroimmune responses. *The Lancet Respiratory Medicine* 9(5): 533–544.
25. Yan B, Yang J, Xie Y, et al. (2021) Relationship between blood eosinophil levels and COVID-19 mortality. *World Allergy Organization Journal* 14(3): 100521.
26. Guan WJ, Ni ZY, Hu Y, et al. (2020) Clinical characteristics of coronavirus disease 2019 in China. *The New England Journal of Medicine* 382(18): 1708–1720.
27. Xu H, Zhong L, Deng J, et al. (2020) High expression of ACE2 receptor of 2019-nCoV on the epithelial cells of oral mucosa. *International Journal of Oral Science* 12(1): 8.
28. Costela-Ruiz VJ, Illescas-Montes R, Puerta-Puerta JM, et al. (2020) SARS-CoV-2 infection: the role of cytokines in COVID-19 disease. *Cytokine & Growth Factor Reviews* 54: 62–75.
29. Johnson BS and Laloraya M (2020) A cytokine super cyclone in COVID-19 patients with risk factors: the therapeutic potential of BCG immunization. *Cytokine & Growth Factor Reviews* 54: 32–42.
30. Merza MY, Hwaiz RA, Hamad BK, et al. (2021) Analysis of cytokines in SARS-CoV-2 or COVID-19 patients in Erbil city, Kurdistan Region of Iraq. *PLoS One* 16(4): e0250330.
31. Ruan Q, Yang K, Wang W, et al. (2020) Clinical predictors of mortality due to COVID-19 based on an analysis of data of 150 patients from Wuhan, China. *Intensive Care Medicine* 46(5): 846–848.
32. Sun S, Cai X, Wang H, et al. (2020) Abnormalities of peripheral blood system in patients with COVID-19 in Wenzhou, China. *Clinica Chimica Acta; International Journal of Clinical Chemistry* 507: 174–180.
33. He Z, Zhao C, Dong Q, et al. (2005) Effects of severe acute respiratory syndrome (SARS) coronavirus infection on peripheral blood lymphocytes and their subsets. *International Journal of Infectious Diseases: Official Publication of the International Society for Infectious Diseases* 9(6): 323–330.
34. Jafarzadeh A, Jafarzadeh S, Nozari P, et al. (2021) Lymphopenia an important immunological abnormality in patients with COVID-19: possible mechanisms. *Scandinavian Journal of Immunology* 93(2): e12967.