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

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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.

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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. 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%. The current SARS CoV-2 genome shares 79% in common with SARS-CoV, but it is more easily transmissible.

The main COVID-19 pathogen transmission route is thought to be through respiratory droplets, although viral particles via fecal contact have also been reported. 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.

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. The most prevalent symptoms are fever, cough, and fatigue. Other symptoms include dyspnea, headache, sputum production, hemoptysis, diarrhea, and lymphopenia, and there is radiographic evidence of pneumonia.

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. 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. The main factors determining the disease severity are primarily related to host factors, such as age and lymphocytopenia. 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 sociodemographic 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 ± 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.
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. 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. The 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. Our findings agree with similar previous studies.13,17

### 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    |

### 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. Diabetes mellitus and obesity are important risk factors for developing severe COVID-19 illness. 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. 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. It has been observed that...
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 (76%), and fatigue (55%) 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

| Variable         | Normal range | Total          | Recovered      | Died           | Mean  | SD    | Mean  | SD    | Mean  | SD    | p value* |
|------------------|--------------|----------------|----------------|----------------|-------|-------|-------|-------|-------|-------|----------|
| Lymphocytes      | 0.9–5.0 x 10⁹/L | 1.54 ± 1.20   | 1.54 ± 1.21    | 1.35 ± 0.86    | 0.584 |
| MID              | 0.1–1.5 x 10⁹/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 x 10⁹/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 ± 3.11   | 0.063 |
| 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 |
| Thromocyte       | 130–400 x 10⁹/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 | 0.5–11 mg/dl  | 0.40 ± 0.20   | 0.41 ± 0.20    | 0.30 ± 0.12    | 0.080 |

*p value 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.
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.
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 significance 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. 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 cases 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 influence 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 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.

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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.

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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.

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Supplemental material

Supplemental material for this article is available online.

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