Journal of Medicine in Scientific Research

Volume 4 | Issue 4 Article 10

Subject Area: Nephrology

Predictors of mortality among Egyptian hemodialysis patients with coronavirus disease 2019: a multicenter retrospective cohort

Amany A. Salem
Cairo University

Enass E. El-Sayed
Ahmad Maher Teaching Hospital, enasss_e@yahoo.com

Hala M. Abd-Elmaguid
Ahmad Maher Teaching Hospital

K Allayeh Abdou
National Research Centre

Mona abd Elmotaleb A. Hussein
National Institute of Diabetes and Endocrinology

See next page for additional authors

Recommended Citation

Salem, Amany A.; El-Sayed, Enass E.; Abd-Elmaguid, Hala M.; Abdou, K Allayeh; A. Hussein, Mona abd Elmotaleb; Abdul-Ghaffar, Muhammed M.; Ali, Omnia S.; Omar, Sheren M.; and Essa, Wael M. (2021) "Predictors of mortality among Egyptian hemodialysis patients with coronavirus disease 2019: a multicenter retrospective cohort," *Journal of Medicine in Scientific Research*: Vol. 4: Iss. 4, Article 10.
DOI: https://doi.org/10.4103/jmisr.jmisr_47_21

Predictors of mortality among Egyptian hemodialysis patients with coronavirus disease 2019: a multicenter retrospective cohort

Authors

Amany A. Salem, Enass E. El-Sayed, Hala M. Abd-Elmaguid, K Allayeh Abdou, Mona abd Elmotaleb A. Hussein, Muhammed M. Abdul-Ghaffar, Omnia S. Ali, Sheren M. Omar, and Wael M. Essa

Predictors of mortality among Egyptian hemodialysis patients with coronavirus disease 2019: a multicenter retrospective cohort

Enass E. El-Sayed[a], K. Allayeh Abdou[b], Amany A. Salem[c], Sheren M. Omar[d], Wael M. Essa[e], Omnia S. Ali[f], Mona abd Elmotaleb A. Hussein[g], Hala M. Abd-Elmaguid[d], Muhammed M. Abdul-Ghaffar[d]

Departments of [a]Nephrology, [d]Gastroenterology and [f]Clinical and Chemical Pathology, Ahmad Maher Teaching Hospital, [b]Department of Water Pollution Research, Virology Laboratory 167, National Research Centre, [c]Department of Public Health and Community Medicine, Faculty of Medicine, Cairo University, [e]Department of Nephrology, El Sahel Teaching Hospital, Cairo, [g]Fellow of Internal Medicine, National Institute of Diabetes and Endocrinology, Cairo, Egypt

Abstract

Background

With a diagnostic problem, the emerging severe acute respiratory syndrome coronavirus 2 caused a devastating global consequence. We were identifying severity/mortality risk variables that assist in determining the need for early admission. As a result, we sought to establish for the first time the clinical, biochemical, and radiological characteristics of coronavirus disease 2019 (COVID-19) in Egyptian hemodialysis patients and to identify the risk factors for mortality.

Patients and methods

In this observational multicenter retrospective cohort study in Egypt, the data of 377 confirmed COVID-19 patients on regular hemodialysis were collected from hospitals affiliated to the general organization of teaching hospitals and institutes through the period of June 6 to July 25, 2020. The diagnosis of COVID-19 was based on radiological findings specific for COVID-19 and a positive reverse-transcriptase reaction-PCR.

Results

Mortality rate was 15.6%. Age group more than 55–75 was statistically significantly higher among patients who died. Multivariate analysis showed that many factors were considered predictors for mortality among maintenance hemodialysis patients, including age group more than 55–75 years [odds ratio (OR)=2.4, 95% confidence interval (CI) 1.1–5.8], receiving immunosuppressive drugs (OR = 2.4, 95% CI 1.1–5.8), fatigue (OR = 4, 95% CI 1.1–13.6), presence of other manifestations (OR = 44.5, 95% CI 1.1–1938), the need for mechanical ventilation (OR = 130.8, 95% CI 8.5–2014), oxygen saturation (OR = 0.93, 95% CI 0.91–0.95), mild anemia (OR = 5.3, 95% CI 2.2–12.7), moderate anemia (OR = 3.7, 95% CI 1.5–9.2), and severe anemia (OR = 5.1, 95% CI 1.5–16.5). While fever (OR = 0.26, 95% CI 0.08–0.79), and myalgia (OR = 0.06, 95% CI 0.005–0.7), were found to be negatively associated with mortality.

Conclusions

In the present study, we demonstrated that the mortality rate was 15.6% among COVID-19 maintenance hemodialysis patients, and many factors are associated with this, including age group more than 55–75, receiving immunosuppressive drugs, fatigue, presence of other manifestations of COVID-19, the need for mechanical ventilation, decreased oxygen saturation, and anemia. While fever and myalgia were found to be negatively associated with mortality.

Keywords: Clinical characteristics, coronavirus disease 2019, Egypt, hemodialysis, risk factors, mortality

Introduction

The first pneumonia case of unknown origin was found in December 2019 in Wuhan city, Hubei province, China [1]. The pathogen was discovered as a novel coronavirus, which has since been renamed severe acute respiratory syndrome coronavirus, and the condition has been dubbed coronavirus

Access this article online

Quick Response Code:

Website: www.jmsr.eg.net

DOI: 10.4103/jmisr.jmisr_47_21

Correspondence to: Enass E. El-Sayed, MD, PhD, Department of Nephrology, Ahmad Maher Teaching Hospital, Enass 75, Mashtal Street, Maadi, Cairo, Egypt
Tel: +20 120 859 0808;
E-mail: enasss_e@yahoo.com

Submitted: 25-Jun-2021 **Revised:** 10-Jul-2021 **Accepted:** 13-Jul-2021 **Published:** 11-Dec-2021

How to cite this article: El-Sayed EE, Abdou KA, Salem AA, Omar SM, Essa WM, Ali OS, *et al*. Predictors of mortality among Egyptian hemodialysis patients with coronavirus disease 2019: a multicenter retrospective cohort. J Med Sci Res 2021;4:328-38.

disease 2019 (COVID-19). [2]. COVID-19 has been labeled a pandemic by the WHO due to its rapid spread [3]. As of April 28, 2020, 184 nations had reported a total of 3 090 844 confirmed cases [4]. COVID-19 infections have been reported in both asymptomatic and presymptomatic patients (who are not yet symptomatic) [5–10].

The clinical spectrum of patients with COVID-19 infection in China's largest cohort ranged from mild to dangerously unwell [11]. Age was identified as a significant risk factor for severe disease, with the highest fatality rates occurring in those aged 80 years and older [11–13]. Additionally, preliminary data from the United States indicated that adverse outcomes were more common in individuals 85 years of age and older, but it was recognized that severe infections could occur in adults of any age group [14,15]. Additionally, comorbid conditions, such as hypertension, diabetes, chronic lung, and renal disease, were associated with severe infections and adverse outcomes [16–18]. NSAIDs, angiotensin-converting enzyme inhibitors, or angiotensin-receptor blockers have all been suggested to exacerbate infection severity [19]. However, there is currently no evidence linking these medications to adverse outcomes. Determining risk factors for COVID-19 infection severity would allow for the identification of patients at high risk who would benefit from close monitoring, aggressive supportive care, and early intervention.

The virus's effect on patients with chronic kidney disease is unknown [20–22]. Given their advanced age and comorbidity, mortality in these patients may be higher than in the general population, particularly in those on dialysis. There is sufficient high-quality data on the preventive and isolation measures that must be implemented in hemodialysis units to prevent the virus's spread [20–22]. However, we still do not know the disease's specific characteristics in this population. To date, only isolated observations or a small case series have been reported regarding prevalence and mortality rates [23–27].

The purpose of this study was to determine the discriminative ability of demographic, hematological, and biochemical biomarkers in dialysis patients with and without severe or fatal forms of COVID-19.

Patients and methods

The ethical committee approved the study protocol of general organization of teaching hospitals and institutes (HAM00124).

Study design and population

The present study was an observational multicenter retrospective cohort. Data were collected from five contributed hemodialysis centers in Egypt study, which recruited 377 confirmed COVID-19 patients on regular hemodialysis who underwent hemodialysis sessions at the period between June 6 and July 25, 2020.

Data collection and operational definitions

The cases were diagnosed using reverse-transcription (RT)-PCR to detect viral RNA in accordance with WHO and Egyptian Ministry of Health and Population definitions [28]. Each patient who met the study's eligibility criteria provided written informed consent. Patients on maintenance hemodialysis (MHD) with COVID-19 met the inclusion criteria (confirmed by RT-PCR test). Patients were divided into groups based on their mortality to determine the risk factors for death in each group. Patients with confirmed COVID-19 infection who were receiving regular hemodialysis were included in the study. We recorded demographic characteristics, such as sex, age, underlying comorbidities, and contact history with a confirmed case. Additionally, we described clinical manifestations, such as fever, headache, fatigue, or myalgia, respiratory manifestations, such as dry cough, expectoration, sore throat, and shortness of breath, gastrointestinal symptoms such as vomiting or diarrhea, and signs of respiratory distress. The following laboratory tests were performed: complete blood count, albumin, D-dimer, lactate dehydrogenase (LDH), serum ferritin, C-reactive protein (CRP), serum urea, and creatinine, as well as grades of anemia [29].

Statistical analysis

STATA for Windows, version 17 was used to conduct the statistical analyses (StataCorp. 2021. Stata Statistical Software: Release 17. College Station, TX: StataCorp LLC). Categorical variables were expressed as numbers and percentages, and their values were compared using the χ^2 or Fisher's exact probability test. Means and SDs were used to represent continuous normally distributed measurements. Patient laboratory parameters were compared between clinical groups (survivors and nonsurvivors) and statistically analyzed, with one-way analysis of variance, and Tukey's multiple-comparison tests used to determine the significance of differences on the ranks. Statistical significance was defined as a P value of 0.05. To analyze the risk factors associated with mortality, a univariate logistic regression model was used for all variables, and variables with a P value of 0.05 were included in multivariate logistic regression models. Continuous variables were divided into two categories based on their normal reference values. In univariate and multivariate logistic regression analysis, odds ratios (OR) and 95% confidence intervals (CI) for the tested variables were calculated. Significant variables in the multivariate regression analysis were evaluated using the DeLong test, which is expressed as the area under the receiver-operating characteristic curve and the estimated sensitivity and specificity.

Results

Demographic results

The majority of included cases were males [198 (52.5%)], with a mean age of 57.39 ± 13 years, and mean BMI of 28.94 ± 6.3, mean dialysis duration of 4.16 ± 4.2 years, and mean interdialytic weight gain were 1.67 ± 1.2 kg. The age group more than 55–75 was statistically significantly higher among patients who died.

Comorbidities

Hypertension 45%, diabetes mellitus 28.3%, cardiac disease 15%,

and liver disease 12.73% were the most common comorbidities recorded among this group of patients. Patients who died were statistically significantly higher than the survivors' group regarding pregnancy (3.77 vs. 11.86%), malignancy (5.35 vs. 11.86%), previous renal transplantation (4.09 vs. 11.86%), receiving chemotherapy (4.4 vs. 11.86%), receiving immunosuppressive drugs (3.77 vs. 14.25%), and the presence of more than five comorbidities (3.77 vs. 11.86%).

Coronavirus disease 2019 symptoms

The clinical presentations were fever 84.4%, dyspnea 46.9%, cough 46.7%, fatigue 34%, myalgia 18.8%, sore throat 17.8%, abdominal pain 13%, diarrhea 12.5%, disturbed conscious level (DCL) 10.6%, skin eruption 10.3%, arterio-venous fistula (AVF) closure 10%, and thrombosis 9.7%. The presence of complications during hemodialysis-session (3.46 vs. 15.25%) and dialysis-session duration less than 4 h (0.54 vs. 42.4%) was found to be statistically significantly higher in the nonsurvivors' group. Fever was found to be less prevalent among nonsurvivors (89.31 vs. 57.63%).

Laboratory investigations

The most frequently reported laboratory abnormalities were anemia hemoglobin (Hb) 9.7 ± 1.8, hematocrit 28.3 ± 6.2, elevated serum ferritin 823 ± 734, elevated CRP 584.9 ± 1295.7, decreased oxygen saturation 94.88 ± 5.6, elevated D-dimer 2200 ± 2133, and elevated LDH 328.8 ± 143.3. About 22.6% of patients had mild anemia, 27.59% moderate anemia, and 7.96% with severe anemia. Patients who died had a statistically significant higher level of CRP (305 ± 15.7 vs. 998 ± 18), D-dimer (118 ± 1687 vs. 4442 ± 897), and LDH (848 ± 148 vs. 278 ± 91), higher prevalence of different grades of anemia, mild (20.44 vs. 33.9%), moderate (26.73 vs. 32.2%), and severe (7.23 vs. 11.86%) than survivors' group.

Isolation and outcome

About 65.3% of the patients had mild disease manifestations, 23.9% with moderate disease manifestations, while 10.9% were critically ill and needed ICU isolation. About 5.3% of the patients needed mechanical ventilation. The mortality rate was 15.6%. Patients who died had a statistically significant higher prevalence of moderate manifestations (22.64 vs. 30.51%), severe manifestations with the need for ICU admission (8.49 vs. 33.77%), and the need for mechanical ventilation (0.63 vs. 30.51%) than survivors' group.

Univariate logistic regression

Our analysis demonstrated a significant association between many variables and COVID-19 mortality among MHD patients. In terms of demographic variables, age more than 55–75 was significantly associated with mortality (OR = 3.7, 95% CI 0.037–0.72). In terms of comorbidities, patients with pregnancy (OR = 3.4, 95% CI 1.3–9.2), previous renal transplantation (OR = 3.2, 95% CI 1.2–8.3), chemotherapy (OR = 2.9, 95% CI 1.1–7.6), receiving immunosuppressive drugs (OR = 4.6, 95% CI 1.8–11.5), and the presence of more than five comorbidities (OR = 3.5, 95% CI 1.3–9.21.3–9.2), were associated significantly with higher risk of death. Regarding COVID-19 presentation, mortality was significantly associated with the presence of other symptoms (OR = 5, 95% CI 1.9–12.7), ICU admission (OR = 3.4, 95% CI 1.6–6.8), need for mechanical ventilation (OR = 69.3, 95% CI 15.5–309.8), and decreased oxygen saturation (OR = 1.2, 95% CI 10.90–0.94), which were associated significantly with higher risk of death. Also, mild anemia (OR = 3.4, 95% CI 1.6–7.3), moderate anemia (OR = 2.5, 95% CI 1.2–5.3), and severe anemia (OR = 3.4, 95% CI 1.2–9.4) were associated significantly with higher risk of death. Regarding fever, it was negatively significantly associated with the risk of death (OR = 0.2, 95% CI 0.08–0.3).

Multivariate analysis

Multivariate analysis was performed based on three models: model 1 adjusted to demographic variables showed that age group more than 55–75 years (OR = 2.4, 95% CI 1.1–5.8) was an independent predictor of COVID-19 mortality among the hemodialysis group. Model 2 adjusted to comorbidity variables showed that receiving immunosuppressive drugs (OR = 2.4, 95% CI 1.1–5.8), fatigue (OR = 4, 95% CI 1.1–13.6), presence of other manifestations (OR = 44.5, 95% CI 1.1–1938), the need for mechanical ventilation (OR = 130.8, 95% CI 8.5–2014), and oxygen saturation (OR = 0.93, 95% CI 0.91–0.95), can be considered as an independent predictor of COVID-19 mortality, while fever (OR = 0.26, 95% CI 0.08–0.79), and myalgia (OR = 0.06, 95% CI 0.005–0.7), were negatively associated with mortality. Model 3 adjusted to investigations shows that mild anemia (OR = 5.3, 95% CI 2.2–12.7), moderate anemia (OR = 3.7, 95% CI 1.5–9.2), and severe anemia (OR = 5.1, 95% CI 1.5–16.5) could be associated significantly with higher risk of death among hemodialysis population (Tables 1-3).

Discussion

COVID-19 infection spread rapidly throughout the world, wreaking havoc with its high infection rate. Similarly, COVID-19 infection in Egypt increased rapidly over a brief period of time [30].

As the COVID-19 pandemic continues, it is critical to identify clinical and laboratory predictors of disease progression to severe and fatal forms [12].

Males were more frequently infected 198 (52.5%) than females 179 (47.5%), with a mean age of 5713 and a significant increase in the age group 55–75 in the nonsurvivor group, which is consistent with a recent meta-analysis [31–33]. Females frequently have a lower susceptibility to viral infections than males, which could be attributed to sex hormones, which are critical for innate and adaptive immunity [34].

In our study, the most common comorbidities were hypertension (45%), diabetes (28.3%), and cardiac disease (15%). Similarly, previous reports indicated that the most prevalent comorbidity in recruited patients was

Table 1: Patients' demography and characteristics

Parameters	Total (n=377)	Survivors' [n=318 (84.4%)]	Death [n=59 (15.6%)]	*P*
Demography				
Hospital				
1	224 (59.4)	217 (68.24)	7 (11.86)	**0.000**
2	58 (15.4)	43 (13.52)	15 (22.42)	
3	29 (7.7)	22 (6.9)	7 (11.86)	
4	32 (8.5)	22 (6.9)	10 (16.95)	
5	34 (9)	14 (4.4)	20 (33.9)	
Age	57.39±13	57.3±12.6	57.6±14.9	0.906
Weight before	82.5±18.6	82.9±19.1	78.9±13.1	0.499
Weight after	79.35±17.25	79.6±17.7	77.6±13.7	0.696
Interdialytic weight gain	1.67±1.2	1.7±1.2	2.2±0.8	0.199
BMI	28.94±6.3	29.2±6.6	27.2±3.3	0.132
Dialysis duration (years)	4.16±4.2	4.14±4.43	4.8±4.14	0.504
Age group				
15-35	21 (5.57)	17 (5.35)	4 (6.78)	**0.001**
>35-55	91 (24.14)	72 (22.6)	19 (32.2)	
>55-75	158 (41.9)	126 (39.6)	32 (54.2)	
>75	107 (28.38)	103 (32.4)	4 (6.78)	
Age >60 years				
No	212 (56.3)	173 (54.4)	39 (66.1)	0.096
Yes	165 (34.7)	145 (45.6)	20 (33.9)	
Sex				
Female	179 (47.5)	149 (46.7)	30 (50.85)	0.573
Male	198 (52.5)	169 (53.1)	29 (49.2)	
Comorbidities				
DM				
No	270 (71.6)	227 (71.4)	43 (72.9)	0.815
Yes	107 (28.3)	91 (28.6)	16 (27.1)	
HTN				
No	207 (54.91)	176 (55.35)	31 (52.54)	0.691
Yes	170 (45.09)	142 (44.65)	28 (47.46)	
Cardiac disease				
No	320 (84.88)	273 (85.85)	47 (79.66)	0.223
Yes	57 (15.12)	45 (14.15)	12 (20.34)	
Lung disease				
No	348 (92.31)	296 (93.08)	52 (88.14)	0.190
Yes	29 (7.69)	22 (6.92)	7 (11.86)	
Liver disease				
No	329 (87.27)	279 (87.74)	50 (84.75)	0.527
Yes	48 (12.73)	39 (12.26)	9 (15.25)	
Pregnancy				
No	358 (94.96)	306 (96.23)	52 (88.14)	**0.009**
Yes	19 (5.04)	12 (3.77)	7 (11.86)	
Malignancy				
No	353 (93.63)	301 (94.65)	52 (88.14)	0.060
Yes	24 (6.37)	17 (5.35)	7 (11.86)	
Previous Tx				
No	357 (94.69)	305 (95.91)	52 (88.14)	**0.014**
Yes	20 (5.31)	13 (4.09)	7 (11.86)	
Chemotherapy				
No	356 (94.43)	304 (95.6)	52 (88.14)	**0.022**
Yes	21 (5.6)	14 (4.4)	7 (11.86)	

Contd...

Table 1: Contd...

Parameters	Total (n=377)	Survivors' [n=318 (84.4%)]	Death [n=59 (15.6%)]	*P*
Immunosuppressive				
No	356 (94.43)	306 (96.23)	50 (84.75)	**0.000**
Yes	21 (5.57)	12 (3.77)	9 (14.25)	
Number of comorbidities >5				
No	358 (94.96)	306 (96.22)	52 (88.14)	**0.031**
Yes	19 (5.04)	12 (3.77)	7 (11.86)	
Symptoms				
Fever				
No	59 (15.65)	34 (10.69)	25 (42.37)	**0.000**
Yes	318 (84.35)	284 (89.31)	34 (57.63)	
Cough				
No	201 (53.32)	171 (53.77)	30 (50.85)	0.679
Yes	176 (46.68)	147 (46.23)	29 (49.15)	
Dyspnea				
No	200 (53.05)	173 (54.4)	27 (45.76)	0.222
Yes	177 (46.95)	145 (45.6)	32 (54.24)	
Sore throat				
No	310 (82.23)	263 (82.7)	47 (79.66)	0.574
Yes	67 (17.77)	55 (17.3)	12 (20.34)	
Diarrhea				
No	330 (87.53)	280 (88.05)	50 (84.75)	0.480
Yes	47 (12.47)	38 (11.95)	9 (15.25)	
Vomiting				
No	375 (99.47)	316 (99.37)	59 (100)	0.541
Yes	2 (0.53)	2 (100)	0	
Abdominal pain				
No	328 (87)	280 (88.05)	48 (81.36)	0.160
Yes	49 (13)	38 (11.95)	11 (18.64)	
Fatigue				
No	249 (66.05)	214 (67.3)	35 (59.32)	0.235
Yes	128 (33.95)	104 (32.7)	24 (40.68)	
Skin eruption				
No	344 (91.25)	292 (91.82)	52 (88.14)	0.357
Yes	33 (8.75)	26 (8.18)	7 (11.86)	
Thrombosis				
No	346 (91.73)	294 (92.45)	52 (88.14)	0.268
Yes	31 (8.22)	24 (7.55)	7 (11.86)	
Closure of AVF				
No	345 (91.51)	293 (92.14)	52 (88.14)	0.311
Yes	32 (8.49)	25 (7.86)	7 (11.86)	
Drowsiness				
No	346 (91.78)	294 (92.45)	52 (88.14)	0.268
Yes	31 (8.22)	24 (7.55)	7 (11.86)	
DCL				
No	337 (89.39)	286 (89.94)	51 (86.44)	0.423
Yes	40 (10.61)	32 (10.06)	8 (13.56)	
Other complications				
No	357 (94.69)	307 (96.54)	50 (84.75)	**0.000**
Yes	20 (5.31)	11 (3.46)	9 (15.25)	
Contact with cases				
No	343 (90.98)	291 (91.51)	52 (88.14)	0.406
Yes	34 (9.02)	27 (8.49)	7 (11.86)	

Contd...

Table 1: Contd...

Parameters	Total (n=377)	Survivors' [n=318 (84.4%)]	Death [n=59 (15.6%)]	*P*
Myalgia				
No	306 (81.17)	254 (79.87)	52 (88.14)	0.136
Yes	71 (18.83)	64 (20.13)	7 (11.86)	
Need for MV				
No	357 (94.69)	316 (99.37)	41 (69.49)	**0.000**
Yes	20 (5.31)	2 (0.63)	18 (30.51)	
Clotting				
No	375 (99.47)	316 (99.37)	59 (100)	0.541
Yes	2 (0.53)	2 (100)	0	
Complications during HDx				
No	371 (98.41)	312 (98.11)	59 (100)	0.288
Yes	6 (1.59)	6 (100)	0	
HDx duration 4 h				
No	27 (7.16)	2 (0.54)	25 (42.4)	**0.02**
Yes	350 (92.84)	316 (99.37)	34 (57.6)	
HDx frequency 3 times/week				
No	12 (3.18)	9 (2.83)	3 (5.08)	0.365
Yes	365 (96.82)	309 (97.17)	56 (94.92)	
Anosmia				
No	348 (92.31)	296 (93.08)	52 (88.14)	0.190
Yes	29 (7.69)	22 (6.92)	7 (11.86)	
Well-being				
No	346 (91.78)	294 (92.45)	52 (88.14)	0.268
Yes	31 (8.22)	24 (7.55)	7 (11.86)	
Anorexia				
No	348 (92.31)	296 (93.08)	52 (88.14)	0.190
Yes	29 (7.69)	22 (6.92)	7 (11.86)	
Loss of weight				
No	349 (92.57)	297 (93.4)	52 (88.14)	0.157
Yes	28 (7.43)	21 (6.6)	7 (11.86)	
Performance				
No	352 (93.37)	299 (94.03)	53 (89.83)	0.234
Yes	25 (6.63)	19 (5.97)	6 (10.17)	
ICU admission				
No	336 (89.12)	291 (91.51)	45 (76.27)	**0.001**
Yes	41 (19.88)	27 (8.49)	14 (23.73)	
Number of symptoms >5				
No	331 (87.8)	279 (87.74)	52 (88.14)	0.966
Yes	46 (12.2)	39 (12.26)	7 (11.86)	
Disease severity				
Home isolation				
Mild	246 (65.3)	219 (68.87)	27 (45.76)	**0.000**
Hospital isolation				
Moderate	90 (23.87)	72 (22.64)	18 (30.51)	**0.000**
ICU isolation				
Severe	41 (10.88)	27 (8.49)	14 (33.73)	**0.000**
Need for mechanical ventilation				
Critically ill	20 (5.31)	2 (0.63)	18 (30.51)	**0.000**
Laboratory				
O_2 saturation	94.88±5.6	94.94±6.23	87.73±10.6	**0.000**
Nonanemic				
>13	158 (41.9)	145 (45.6)	13 (22)	**0.006**
Mild anemia(grade I)				
10-<13	85 (22.6)	65 (20.44)	20 (33.9)	

Contd...

Table 1: Contd...

Parameters	Total (n=377)	Survivors' [n=318 (84.4%)]	Death [n=59 (15.6%)]	P
Moderate anemia (grade II)				
8-<10	104 (27.59)	85 (26.73)	19 (32.2)	
Severe anemia (grade III)				
<8	30 (7.96)	23 (7.23)	7 (11.86)	
Hb%	9.7±1.8	10.1±7	9.8±1.9	0.292
HCT	28.3±6.2	28.4±6	27.5±6.7	0.820
WBCs	8.9±6.3	8.2±4.7	09.4±5.4	0.221
Lymph	1.3±1	1.3±1.1	1.2±0.6	0.511
PLT	242.49±95.6	242±95	243±100	0.928
Serum ferritin	823.3±734	863±815	654±72	0.654
CRP	584.9±12.7	305±15.7	998±18	0.024
Blood urea	135.6±38	136.8±39	122±20	0.607
Serum creatinine	9.5±4	9.5±4.1	9.8±3.9	0.914
D-dimer	2200±2133	118±1687	4442±897	**0.0013**
LDH	328.8±143.3	348±148	278±91	**0.004**
Serum albumin	3.7±2.6	3.8±0.4	3.7±0.3	0.507
Lymphopenia				
No	326 (86.47)	274 (86.2)	52 (88.14)	0.684
Yes	51 (13.53)	44 (13.84)	7 (11.68)	
Lymphocytosis				
No	180 (47.75)	149 (46.86)	31 (52.54)	0.422
Yes	197 (52.25)	169 (53.14)	28 (47.46)	
Thrombocytopenia				
No	348 (92.3)	296 (93.1)	52 (88.14)	0.190
Yes	29 (7.69)	22 (6.9)	7 (11.86)	
Thrombocytosis				
No	169 (44.83)	138 (43.4)	31 (52.54)	0.194
Yes	208 (55.17)	180 (56.6)	28 (47.46)	

Significant *P* value. CRP, C-reactive protein; DM, diabetes mellitus; Hb, hemoglobin; HCT, hematocrit; HTN, hypertension; LDH, lactate dehydrogenase; MV, mechanical ventilation; PLT, platelet; WBC, white blood cell.

hypertension, followed by diabetes mellitus [31,35]. Pregnancy, malignancy, previous renal transplantation, chemotherapy, immunosuppressive drugs, presence of more than five comorbidities, and other symptoms were significantly more prevalent in the nonsurvivors' group, which is consistent with Oakes *et al.*'s [35] conclusion that pregnancy significantly increases the risk of severe COVID-19 as defined by nonadmission based. Additionally, according to Thng *et al.* [36], immunosuppression may increase a patient's risk of infection. With severe acute respiratory syndrome coronavirus 2 and the development of severe complications, best-practice guidelines worldwide currently recommend that immunosuppressive treatment be continued in patients who require it, except for those who require high-dose corticosteroid therapy or who have associated risk factors for severe COVID-19 [37]. COVID-19-related mortality appears to be primarily determined by age, sex, and comorbidities in cancer patients. We were unable to find evidence that cancer patients receiving cytotoxic chemotherapy or other anticancer treatment face an increased risk of death from COVID-19 when compared with those who are not receiving treatment [38].

In line with previous reports, we discovered that fever (84.4%), dyspnea (46.7%), cough (46.7%), and fatigue (34%) were the most common presenting symptoms, while myalgia (18.8%), sore throat (17.8%), abdominal pain (13%), diarrhea (12.5%), DCL (10.6%), skin eruption (10.3%), and AVF closure (10%) were the least common, where they are less prevalent [32]. The most frequently encountered symptom in Goicoechea *et al.* [38] and Wang *et al.* [24] studies was fever (67 and 60%). According to Zheng *et al.* [39], fever was associated with the progression of COVID-19, including severe illness and death. According to our study, fever was statistically significantly higher in the survivor group. Concerning COVID-19 severity, a Chinese study reported that the majority of patients (59.79%) had mild disease, 21.13% had moderate disease, 12.89% had severe disease, and 6.19% had died [40,41]. On the other hand, another study found that the majority (47.5%) had severe disease, while 37.8% had moderate disease, 14.2% were in critical condition, and 0.5% had a mild infection [42]. Meanwhile, the majority of patients in our study had mild disease manifestations (65.3%), 23.9% had moderate disease manifestations, and 10.9% were critically ill and required ICU isolation. About 5.3% of patients required mechanical ventilation. COVID-19 was found to be moderately severe in the majority of patients, which is consistent with a meta-analysis finding that 25.6% of patients presented with severe illness [30,43]. These

Table 2: Univariate regression analysis of risk factors

Variables	OR (CI)	*P*
Age group >55-75	3.7 (0.037-0.72)	0.019
BMI	0.94 (0.88-1.06)	0.335
Pregnancy	3.4 (1.3-9.2)	0.013
Malignancy	2.3 (0.94-6)	0.167
Previous transplantation	3.2 (1.2-8.3)	0.019
Chemotherapy	2.9 (1.1-7.6)	0.028
Immunosuppression drugs	4.6 (1.8-11.5)	0.001
Number of comorbidities >5	3.5 (1.3-9.2)	0.012
Fever	0.2 (0.08-0.3)	0.000
O_2 saturation	1.2 (0.90-0.94)	0.000
Other symptoms	5 (1.9-12.7)	0.001
Number of symptoms >5	0.9 (0.5-1.7)	0.825
ICU admission	3.4 (1.6-6.8)	0.001
Need for MV	69.3 (15.5-309.8)	0.000
Hospital 2	10.8 (4.2-28)	0.000
Hospital 3	9.9 (3.2-30.8)	0.000
Hospital 4	14 (4.8-40.7)	0.000
Hospital 5	44.2 (16-122)	0.000
D-dimer	1 (0.99-1)	0.100
Urea	0.99 (0.9-1)	0.591
Creatinine	1.02 (0.7-1.4)	0.910
Interdialytic weight gain	1.46 (0.8-2.6)	0.204
Serum albumin	0.6 (0.6-5.7)	0.670
LDH	0.994 (0.98-1)	0.441
D-dimer	1 (0.99-1)	0.100
CRP	1 (0.99-1)	0.117
Serum ferritin	0.99 (0.997-1)	0.604
PLT	1 (0.995-1)	0.987
WBCs	1.04 (0.97-1.12)	0.224
Lymphocytes	0.85 (0.5-1.36)	0.510
Hb%	0.991 (0.93-1.05)	0.788
HCT	0.977 (0.8-1.06)	0.601
Mild anemia	3.4 (1.6-7.3)	0.001
Moderate anemia	2.5 (1.2-5.3)	0.018
Severe anemia	3.4 (1.2-9.4)	0.019

CI, confidence interval; CRP, C-reactive protein; Hb, hemoglobin; HCT, hematocrit; LDH, lactate dehydrogenase; MV, mechanical ventilation; OR, odds ratio; PLT, platelet; WBC, white blood cell.

variations in the proportion of patients with the severe disease between studies could be attributed to the use of different classification criteria or the time of patient presentation to the hospital, patient characteristics, and geographical distribution. Late patient admission increases the likelihood of entering a severe or critical stage, whereas early medical evaluation decreases the severity. In our study, the majority of patients with statistically more significant severe symptoms were nonsurvivors 14 (23.73%), while survivors 219 had statistically more significant mild symptoms (68.87%).

The Hb concentration is a critical factor in determining the blood's oxygen-binding capacity. The interaction of COVID-19 with Hb molecules may result in hemolysis and a decrease in Hb levels. Patients with low Hb levels are unable to meet their increased peripheral tissue oxygen demand [26]. In our study, the most frequently reported laboratory abnormalities were anemia Hb 9.7 ± 1.8, hematocrit 28.3 ± 6.2. In total, 158 (41.9%) patients were nonanemic with Hb% more than 13 g/dl, patients with mild anemia were 85 (22.6%) with Hb% 10 to less than 13 g/dl, 104 (27.59%) with moderate anemia Hb% 8 to less than 10 g/dl, and 30 (7.96%) with severe anemia Hb% less than 8 g/dl [29]. Patients who died had lower Hb%. These results were consistent with Turgutalp *et al.* findings [57].

We also reported elevated serum ferritin 823 ± 734, elevated CRP 584.9 ± 1295.7, decreased oxygen saturation 94.88 ± 5.6, elevated D-dimer 2200 ± 2133, elevated LDH 328.8 ± 143.3, blood urea 135.6 ± 38, and serum creatinine 9.5 ± 4. This result is consistent with findings in the MHD population reported by Goicoechea *et al.* [24] and Turgutalp *et al.* [12]. In addition, higher CRP, LDH, and D-dimer were found statistically significantly higher in patients who died.

Lymphopenia is a frequent complication of COVID-19 and may serve as an early prognostic indicator [44]. Only 51 (14%) of patients were with lymphopenia and 197 (52%) with lymphocytosis.

Additionally, the cytokine storm results in increased blood coagulability, which eventually results in thrombocytopenia. In total, 29 (7.7%) had thrombocytopenia, while 208 (55%) had thrombocytosis. While lymphopenia, elevated CRP, serum ferritin, and D-dimers were the most frequently reported laboratory abnormalities in the general population, lymphopenia, elevated CRP, serum ferritin, and D-dimers were the most frequently reported laboratory abnormalities in all patients. The predominance of lymphopenia in COVID-19 suggests that the virus may act on lymphocytes, particularly T lymphocytes, causing a decrease in CD4 expression [45].

Cytokine storms associated with lymphopenia, leukopenia, and elevated CRP levels were associated with the severity of COVID-19 [46]. At admission, thrombocytopenia was an independent risk factor for in-hospital mortality, with a nearly threefold increased risk of death compared with those without thrombocytopenia [47].

It is difficult to implement social isolation measures and to prevent and control infectious diseases, such as COVID-19, in dialysis patients because they spend time in crowded waiting areas prior to and following hemodialysis sessions [48]. MHD patients' immune systems are less efficient, which may alter their response to COVID-19. As a result, it is unsurprising to see increased mortality rates in patients with MHD [49]. As of December 12, 2020, the WHO reported that there had been over 70 million confirmed cases of COVID-19 worldwide, with 1 588 854 deaths (2.3%) [50]. In our study, the mortality rate of MHD with COVID-19 patients was 59 (15.5%), with 20 (5.3%) requiring mechanical ventilation and 41 (10.9%) requiring ICU admission. This was more than six times the rate for the general population. Previous Italian studies revealed significantly higher mortality rates in small numbers of hemodialysis patients, as

Table 3: Multivariate regression analysis of risk factors

Model	Variables	OR	*P*
1	Age >55-75	2.4 (1.1-5.8)	0.062
Adjusted to comorbidities	Male	0.9 (0.4-1.7)	0.773
	DM	0.6 (0.26-1.4)	0.244
	HTN	1.2 (0.6-2.4)	0.578
	Cardiac	0.99 (0.4-2.8)	0.983
	Lung	9.42e-13 (0)	0.990
	Liver	0.3 (0.04-1.7)	0.159
	Pregn	1.76e+25 (0)	0.994
	Malign	1.46e-12 (0)	0.994
	Tx	1.70e-07 (0)	0.998
	Chemo	275830.6 (0)	0.996
	Immunosuppression drugs	9.5 (2.6-829)	0.009
2	Fever	0.26 (0.08-0.79)	0.018
	Cough	0.45 (0.14-1.4)	0.192
Adjusted to clinical manifestations	Dyspnea	0.89 (0.3-2.8)	0.854
	Sore throat	0.6 (0.06-5.6)	0.621
	Diarrhea	1.0 (0.08-11.6)	0.987
	Abdominal pain	5.1 (0.9-28.7)	0.064
	Fatigue	4 (1.2-13.6)	0.024
	DCL	0.17 (0.005-6)	0.320
	Myalgia	0.06 (0.005-0.7)	0.021
	Other	44.5 (1-1938)	0.049
	MV	130.8 (8.5-2014)	0.000
	Loss of weight	1.1 (0.002-746)	0.967
	Perform	2.4 (0.04-160)	0.678
	O2 saturation	0.93 (0.91-0.95)	0.001
3	Mild anemia	5.3 (2.2-12.7)	0.000
Adjusted to laboratory investigations	Moderate anemia	3.7 (1.5-9.2)	0.004
	Severe anemia	5.1 (1.5-16.5)	0.007
	Lymphopenia	1.7 (0.6-4.7)	0.286
	Lymphocytosis	1.04 (0.4-2.7)	0.924
	Thrombocytopenia	0.7 (0.3-1.8)	0.477
	Thrombocytosis	1.8 (0.7-4.5)	0.224

DM, diabetes mellitus; HTN, hypertension; MV, mechanical ventilation; OR, odds ratio.

high as 41% (41 patients with a mean age of 73) [51] and 24% (mean age, 21 patients, not mentioned) [52]. Spain also had a high mortality rate (30.5%), owing to a population that was more elderly (mean age 71 years) [24]. According to a New York study, 31.7% of 419 hemodialysis and peritoneal dialysis patients (mean age 74 years) hospitalized with COVID-19 died, and 89 required mechanical ventilation (21.2%) [53]. These studies had a higher mortality rate and required mechanical ventilation than ours. This large disparity between mortality and mechanical ventilation rates may be explained by the patients' median ages being significantly different. COVID-19 MHD patients had a higher mortality rate than the general population in all of these studies. This difference is easily explained by the presence of multiple comorbid conditions in patients with MHD, such as a high rate of cardiovascular comorbidity. Alberici *et al.* [51] reported that a significant proportion of MHD patients had comorbid conditions, such as cardiovascular disease, hypertension, diabetes, or lung disease, all of which were associated with poor outcomes in patients with COVID-19.

The analysis of risk factors for COVID-19 mortality revealed that advanced age, pregnancy, previous transplantation, chemotherapy, immunosuppressive drugs, the presence of additional symptoms, anemia, fatigue, myalgia, and other manifestations, and the requirement for mechanical ventilation might all be risk factors for mortality in hemodialysis populations. While fever was associated with a decreased risk of death, concurring with Xavier and colleagues.[54] In general population studies, lymphopenia, thrombocytopenia, and elevated CRP levels were associated with increased COVID-19 mortality [55,56]. The COVID-19 study on MHD found that high CRP levels were associated with a higher mortality rate. Ng *et al.* [52] demonstrated that increased mortality risk was associated with increased age, mechanical ventilation, lymphopenia, blood urea nitrogen, and serum ferritin levels in a large group of hemodialysis patients. Kenan and colleagues examined several laboratory findings, particularly thrombocytopenia and a high AST level during hospitalization, that were identified as risk factors for mortality

in COVID-19 MHD patients. Additionally, similar to the Ng *et al.* [53] study, age and ferritin levels were found to be associated with mortality.

Conclusions

We demonstrated that the mortality rate among COVID-19 MHD patients is 15.6% and that numerous factors contribute to this, including age group more than 55–75, immunosuppressive drug use, fatigue, and other COVID-19 manifestations, the need for mechanical ventilation, decreased oxygen saturation, and anemia. While fever and myalgia were found to be associated with a decreased risk of death.

By the end of May, the Egyptian Ministry of Health had recommended that mild and some moderate cases are treated at home. We are providing an overview of the disease in Egypt and the risk factors for severe disease, so that cases managed at home will be alerted to the need for early hospitalization if they have any of these risk factors.

As a result, additional research on variable risk factors and laboratory parameters in severe illness should be conducted, taking into account the methodological differences in defining severe disease.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

References

1. World Health Organization. Pneumonia of unknown cause—China. Available at: https://www.who.int/csr/don/05-*january-2020-pneumonia-of-unkown-cause-china/en/*. [Accessed April 20, 2020].
2. Lu R, Zhao X, Li J, Niu P, Yang B, Wu H, *et al*. Genomic characterisation and epidemiology of 2019 novel coronavirus: Implications for virus origins and receptor binding. The lancet 2020;395:565-74.
3. WorldCat World Health Organization. Home page. Available at: https://www.who.int. [Accessed April 20, 2020].
4. Johns Hopkins University. COVID-19 dashboard by the Center for Systems Science and Engineering (CSSE) at Johns Hopkins University (JHU). Available at: https://gisanddata.maps.arcgis.com*/apps/opsdashboard/index.html#/bda7594740fd40299423467b48e9ecf6*. [Accessed April 28, 2020].
5. Hoehl S, Rabenau H, Berger A, Kortenbusch M, Cinatl J, Bojkova D, *et al*. Evidence of SARS-CoV-2 infection in returning travelers from Wuhan, China. New England Journal of Medicine. 2020;382:1278-80.
6. Hu Z, Song C, Xu C, Jin G, Chen Y, Xu X, *et al*. Clinical characteristics of 24 asymptomatic infections with COVID-19 screened among close contacts in Nanjing, China. Sci China Life Sci 2020; 63:706–711.
7. World Cat, Wang Y, Liu Y, Liu L, Wang X, Luo N, Ling L. Clinical outcome of 55 asymptomatic cases at the time of hospital admission infected with SARS-coronavirus-2 in Shenzhen, China. J Infect Dis 2020; 11:1770–1774.
8. Bai Y, Yao L, Wei T, Tian F, Jin DY, Chen L, *et al*. Presumed Asymptomatic Carrier Transmission of COVID-19. JAMA 2020;323:1406-1407. doi: 10.1001/jama.2020.2565. PMID: 32083643; PMCID: PMC7042844.
9. Kwok KO, Wong VW, Wei WI, Wong SY, Tang JW. Epidemiological characteristics of the first 53 laboratory-confirmed cases of COVID-19 epidemic in Hong Kong, 13 February 2020. Eurosurveillance. 2020;25:2000155.
10. Roxby AC, Greninger AL, Hatfield KM, Lynch JB, Dellit TH, James A, *et al*. Detection of SARS-CoV-2 among residents and staff members of an independent and assisted living community for older adults—Seattle, Washington, 2020. Morbidity and Mortality Weekly Report. 2020;69:416.
11. WorldCat. Wu Z, McGoogan JM. Characteristics of and important lessons from the coronavirus disease 2019 (COVID-19) outbreak in china: summary of a report of 72314 cases from the Chinese Center for Disease Control and Prevention. JAMA 2020; 323:1239–1242.
12. Guan WJ, Ni Z, Hu Y, Liang WH, Ou CQ, He JX, *et al*. Clinical characteristics of coronavirus disease 2019 in China. N Engl J Med 2020; 382:1708–1720.
13. Wang D, Hu B, Hu C, Zhu F, Liu X, Zhang J, *et al*. Clinical characteristics of 138 hospitalized patients with 2019 novel coronavirus–infected pneumonia in Wuhan, China. Jama 2020;323:1061-9.
14. WorldCatCDC COVID-19 Response Team. Severe outcomes among patients with coronavirus disease 2019 (COVID-19)—United States, February 12–March 16, 2020. Morb Mortal Wkly Rep 2020; 69:343–346.
15. Arentz M, Yim E, Klaff L, Lokhandwala S, Riedo FX, Chong M, *et al*. Characteristics and outcomes of 21 critically ill patients with COVID-19 in Washington State. Jama 2020;323:1612-4.
16. Zhou F, Yu T, Du R, Fan G, Liu Y, Liu Z, *et al*. Clinical course and risk factors for mortality of adult inpatients with COVID-19 in Wuhan, China: A retrospective cohort study. The lancet 2020;395:1054-62.
17. Xu L, Mao Y, Chen G. Risk factors for 2019 novel coronavirus disease (COVID-19) patients progressing to critical illness: A systematic review and meta-analysis. Aging (Albany NY). 2020;12:12410.
18. WorldCatCDC COVID-19 Response Team. Preliminary estimates of the prevalence of selected underlying health conditions among patients with coronavirus disease 2019—United States, February 12-March 28, 2020. Morb Mortal Wkly Rep 2020; 69:382–386.
19. WorldCat, Fang L, Karakiulakis G, Roth M. Are patients with hypertension and diabetes mellitus at increased risk for COVID-19 infection?. Lancet Respir Med 2020; 8:e21.
20. Basile C, Combe C, Pizzarelli F, Covic A, Davenport A, Kanbay M, *et al*. Recommendations for the prevention, mitigation and containment of the emerging SARS-CoV-2 (COVID-19) pandemic in haemodialysis centres. Nephrology Dialysis Transplantation 2020;35:737-41.
21. de Sequera Ortiz P, Quiroga B, de Arriba de la Fuente G, Macía Heras M, Salgueira Lazo M, Del Pino Y Pino MD. En representación de la Sociedad Española de Nefrología. Protocol against coronavirus diseases in patients on renal replacement therapy: Dialysis and kidney transplant. Nefrologia (Engl Ed). 2020;40:253-257. English, Spanish. doi: 10.1016/j.nefro.2020.03.001. Epub 2020 Apr 2. PMID: 32249016; PMCID: PMC7270500.
22. Li J, Xu G. Lessons from the experience in Wuhan to reduce risk of COVID-19 infection in patients undergoing long-term hemodialysis. Clin J Am Soc Nephrol 2020; 15:717–719.
23. Ferrey AJ, Choi G, Hanna RM, Chang Y, Tantisattamo E, Ivaturi K, *et al*. A case of novel coronavirus disease 19 in a chronic hemodialysis patient presenting with gastroenteritis and developing severe pulmonary disease. American journal of nephrology 2020;51:337-42.
24. Ma Y, Diao B, Lv X, Zhu J, Liang W, Liu L, *et al*. 2019 novel coronavirus disease in hemodialysis (HD) patients: Report from one HD center in Wuhan, China. MedRxiv 2020.
25. Ma Y, Diao B, Lv X, Zhu J, Liang W, Liu L. COVID-19 in hemodialysis (HD) patients: report from one HD center in Wuhan, China. medRxiv. 2020; [Epub ahead of print]. DOI: https://doi. org/10.1101/2020.02.;24.
26. Scarpioni R, Manini A, Valsania T, De Amicis S, Albertazzi V, Melfa L, *et al*. Covid-19 and its impact on nephropathic patients: the experience at Ospedale "Guglielmo da Saliceto" in Piacenza. G Ital Nefrol 2020;37:1-5.
27. Alberici F, Delbarba E, Manenti C, Econimo L, Valerio F, Pola A, *et al*. A report from the Brescia Renal COVID Task Force on the clinical characteristics and short-term outcome of hemodialysis patients with SARS-CoV-2 infection. Kidney international 2020;98:20-6.
28. World Health Organization. Clinical management of severe acute respiratory infection (SARI) when COVID-19 disease is suspected: interim guidance, 13 March 2020. https://extranet. who. int/iris/restricted/bitstream/handle/10665/331446/WHO-2019-nCoV-clinical-2020.4-eng. pdf? sequence= 1& isAllowed= y. 2020. [Last

accessed on Dec 2020].
29. Tas F, Eralp Y, Basaran M, Sakar B, Alici S, Argon A, *et al*. Anemia in oncology practice: relation to diseases and their therapies. Am J Clin Oncol 2002; 25:371–379.
30. Henry BM, De Oliveira MH, Benoit S, Plebani M, Lippi G. Hematologic, biochemical and immune biomarker abnormalities associated with severe illness and mortality in coronavirus disease 2019 (COVID-19): a meta-analysis. Clin Chem Lab Med 2020; 58:1021–1028.
31. Alhazzani W, Møller MH, Arabi YM, Loeb M, Gong MN, Fan E, *et al*. Surviving Sepsis Campaign: guidelines on the management of critically ill adults with Coronavirus Disease 2019 (COVID-19). Intensive care medicine 2020. p. 1-34.
32. Qian K, Deng Y, Tai Y, Peng J, Peng H, Jiang L. Clinical characteristics of 2019 novel infected coronavirus pneumonia: a systematic review and meta-analysis. medRxiv 2020; 80:656–665.
33. Klein SL, Huber S. Sex differences in susceptibility to viral infection. InSex hormones and immunity to infection. Springer, Berlin, Heidelberg. 2010. p. 93-122.
34. Klein SL, Roberts C. Sex hormones and immunity to infection. Heidelberg: Springer; 2010.
35. Oakes MC, Kernberg AS, Carter EB, Foeller ME, Palanisamy A, Raghuraman N, Kelly JC. Pregnancy as a risk factor for severe coronavirus disease 2019 using standardized clinical criteria. Am J Obstetr Gynecol 2021; 3:100319.
36. Thng ZX, De Smet MD, Lee CS, Gupta V, Smith JR, McCluskey PJ, *et al*. COVID-19 and immunosuppression: a review of current clinical experiences and implications for ophthalmology patients taking immunosuppressive drugs. Br J Ophthalmol 2021; 105:306–310.
37. Lee LY, Cazier JB, Starkey T, Turnbull CD, Team UC, Kerr R, Middleton G. COVID-19 mortality in patients with cancer on chemotherapy or other anticancer treatments: a prospective cohort study. Lancet 2020; 395:1919–1926.
38. Goicoechea M, Sánchez Cámara LA, Macías N, Morales AM, Rojas AG, Bascuñana A, *et al*. COVID-19: clinical course and outcomes of 36 hemodialysis patients in Spain. Kidney Int 2020; 98:27–34.
39. Zheng Z, Peng F, Xu B, Zhao J, Liu H, Peng J. Risk factors of critical and mortal COVID-19 cases: a systematic literature review and meta-analysis. J Infect 2020; 81:e16–e25.
40. Zhang H, Shang W, Liu Q, Zhang X, Zheng M, Yue M. Clinical characteristics of 194 cases of COVID-19 in Huanggang and Taian, China. Infection 2020; 48:1–8.
41. Zheng X, Zhao C, Peng S, Jian S, Liang B, Wang X, *et al*. 2014:2065-76.
42. Zhang H, Shang W, Liu Q, Zhang X, Zheng M, Yue M. Clinical characteristics of 194 cases of COVID-19 in Huanggang and Taian, China. Infection 2020;48:687-94.
43. Cavezzi A, Troiani E, Corrao S. COVID-19: hemoglobin, iron, and hypoxia beyond inflammation. A narrative review. Clin Pract 2020; 10:1271–1277.
44. Mjaess G, Lilly E, Mansour R, Albisinni S, Nemr E, Aoun F, *et al*. COVID-19 and BCG: Where's the challenge?. World Journal of Ur.
45. Huang C, Wang Y, Li X, Ren L, Zhao J, Hu Y, *et al*. Clinical features of patients infected with 2019 novel coronavirus in Wuhan, China. Lancet 2020; 395:497–506.
46. Liu Y, Sun W, Guo Y, Chen L, Zhang L, Zhao S, *et al*. Association between platelet parameters and mortality in coronavirus disease 2019: retrospective cohort study. Platelets 2020; 31:490–496.
47. Park HC, Lee YK, Lee SH, Yoo KD, Jeon HJ, Ryu DR, *et al*. Middle East respiratory syndrome clinical practice guideline for hemodialysis facilities. Kidney Res Clin Pract 2017; 36:111–116.
48. Collins AJ, Kliger AS. Urgent: stop preventable infections now. Clin J Am Soc Nephrol 2018; 13:663–665.
49. https://www.who.int/emergen*cies/diseases/novel-coronavirus-2019?gclid=CjwKCAiA_Kz-BRAJEiwAhJNY71bEwmKrdyUeQB7Gl3LZi1JYE2AmbjgvkkzfiK2DvSd8ya8nqDV0KRoCWHUQAvD_BwE.*
50. Scarpioni R, Manini A, Valsania T, Amicis SD, Albertazzi V, Melfa L, *et al*. Covid-19 and its impact on nephropathic patients: the experience at Ospedale "Guglielmo da Saliceto" in Piacenza. G Ital Nefrol 2020; 37:1–5.
51. Alberici F, Delbarba E, Manenti C, Econimo L, Valerio F, Pola A, *et al*. Management of patients on dialysis and with kidney transplant during SARS-COV-2 (COVID-19) pandemic in Brescia, Italy. Kidney Int Rep 2020; 5:580–585.
52. Ng JH, Hirsch JS, Wanchoo R, Sachdeva M, Sakhiya V, Hong S, *et al*. Outcomes of patients with end-stage kidney disease hospitalized with COVID-19. Kidney Int 2020; 98:1530–1539.
53. Zhou F, Yu T, Du R, Fan G, Liu Y, Liu Z, *et al*. Clinical course and risk factors for mortality of adult inpatients with COVID19 in Wuhan, China: a retrospective cohort study. Lancet 2020; 395:1054–1062.
54. Xavier AR, Silva JS, Almeida JP, Conceição JF, Lacerda GS, Kanaan S. COVID-19: Clinical and laboratory manifestations in novel coronavirus infection. Jornal Brasileiro de Patologia e Medicina Laboratorial 2020; 1:56.
55. Zhang G, Hu C, Luo L, Fang F, Chen Y, Li J, *et al*. Clinical characteristics of 3062 COVID-19 patients: a meta-analysis. J Med Virol 2020; 92:1902–1914.
56. Trujillo H, Caravaca-Fontán F, Sevillano Á, Gutiérrez E, Caro J, Gutiérrez E, *et al*. SARS-CoV-2 infection in hospitalized patients with kidney disease. Kidney Int Rep 2020; 5:905–909.
57. Turgutalp K, Ozturk S, Arici M, Eren N, Gorgulu N, Islam M, *et al*. Determinants of mortality in a large group of hemodialysis patients hospitalized for COVID-19. BMC Nephrol 2021; 22:1–0.