

ARTICLE



The effects of antihypertensive medications on severity and outcomes of hypertensive patients with COVID-19

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In Covid-19 pandemic, specific comorbidities are associated with the increased risk of worse outcomes and increased severity of lung injury and mortality. The aim of this study was to investigate the effects of antihypertensive medications on the severity and outcomes of hypertensive patients with COVID-19. This retrospective observational study conducted on patients with COVID-19 who referred to Afzalipour Hospital, Kerman, Iran during the six months from 19 February 2020 to 20 July 2020. The data were collected through medical chart reviews. We assessed 265 patients with Covid-19 and they stratified based on hypertension and type of antihypertension medications. The data were described and Student's *t*-test, Mann–Whitney *U* and Fisher exact test were run to compare the patients' demographical and clinical information. The qualitative variables were compared using the by SPSS software version 23. The results of the present study showed that hypertension was a prevalent comorbidity among patients with COVID-19 and hypertensive patients compared to other patients without any comorbidity who were older (*P*-value: 0.03). The oxygen saturation was higher for the patients in the control group than hypertensive patients (*P*-value: 0.01). The severity of COVID-19 and its outcome were not different between the patients who took or did not take antihypertensive medications and also the type of antihypertensive medications. Hypertensive patients did not show any significant difference in survival, hospital stay, ICU admission, disease severity, and invasive medical ventilation in other normotensive patients with COVID-19.

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INTRODUCTION

Currently, the coronavirus pandemic is causing panic among people all around the world and thousands of people are daily infected with it and hundreds are dying. COVID-19 infection is expanding to over 198 countries and infected 750,890 people, and has caused 36,405 deaths from December 2019 to March 2020. Of these, 50,349 were confirmed cases in the Eastern Mediterranean region, and 2945 died [1].

Specific comorbidities are associated with the increased risk of infection and worse outcomes with the development or increased severity of lung injury and mortality. The most common comorbidities were hypertension (30%), diabetes (19%), coronary heart disease (8%) and also cardiovascular disease (6%) [2, 3]. Some previous studies suggested that hypertensive patients with COVID-19 are at a greater risk of ICU admission and low survival [4, 5]. Coronavirus transports its genetic materials into affected cells, after entering the body. This incorporation is mediated by glycosylated spike proteins on the surface of the virion interacting with proper surface receptors on the membrane of host cells, and Angiotensin-converting enzyme 2 (ACE2) receptor is a human cell protein to which CoV spike proteins are bound [6]. Antihypertensive medications that control the Angiotensin-Converting Enzyme (ACE) or the receptor blocker of this enzyme may prevent severe disease in patients with high blood pressure. ACE2 plays a vital role

in the Renin-Angiotensin System (RAS) where juxtaglomerular cells in the kidneys activate pre-renin and directly release renin into the bloodstream. Renin itself is an enzyme that affects a plasma protein called angiotensinogen, and produces a peptide: angiotensin I, then the angiotensin I is converted to angiotensin II by Angiotensin-converting enzyme (ACE), a protein on vascular endothelial cells [7].

Some studies have shown that ACE2 has a protective effect on lung fibrogenesis and inflammation while other studies have reported different results [8, 9]. Besides, ACE2 has a determinant antifibrotic role in the lung injury induced by sepsis, acid aspiration, SARS, and lethal avian influenza A H5N1 virus [10]. The point which should be considered is CoV-induced mortality is due to lung injuries [11] and lung fibrosis induced by COVID-19 may be due to ACE-AngII-AT1 over activation [12]. Furthermore, some findings have suggested that ACE inhibitors had different effects in patients with COVID-19, and ACE inhibitor use was associated with better survival [13].

Given the advanced age of most patients with high blood pressure and the use of antihypertensive medications by this group, attention should be paid to them in the COVID-19 pandemic. To this end, this study aimed to investigate the effects of antihypertensive medications on the severity and outcomes of hypertensive patients with COVID-19.

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MATERIAL AND METHODS

Subject and setting

The present study was a retrospective observational study conducted on patients with COVID-19 who referred to Afzalipour Hospital, the major referral center for patients with COVID-19 in Kerman, Iran. The participants were all hospitalized confirmed patients with COVID-19 during the six months from 19 February 2020 to 20 July 2020. These patients had confirmed positive SAR-COV-2 RNA with RT-PCR or abnormal chest CT scan and with clinical symptoms like respiratory signs. Sampling was not restricted to sex but pediatric patients aged lower than 18 years were excluded. Hypertension was operationalized in this study as a history of diastolic blood pressure of ≥ 90 mmHg or a systolic blood pressure of ≥ 140 mmHg or a history of antihypertensive medication use [14]. We assessed 265 patients with Covid-19 and they stratified based on hypertension and type of antihypertension medications. To compare the demographic and clinical information and laboratory findings of the patients with and without hypertension, a convenience sample of patients without any comorbidity were selected as the control group (Fig. 1).

Data collection

In the present study, the data were collected through medical chart reviews. We used a checklist for recording the data. The patients' demographic data such as age, sex, cigarette smoking and opium consumption habits and status of hypertension, and name of antihypertensive medications were recorded in the first part of the checklist. The second part of checklist assessed the laboratory findings for the first time after hospital admission. The clinical data such as hospital stay, ICU admission, disease severity (based

on saturated oxygen $\leq 93\%$ and $>94\%$ as severe and not severe, respectively), invasive mechanical ventilation, and the outcome (discharge and death) were recorded in the last part of the checklist.

Ethical approval

The protocol of the present study was reviewed and approved by the Ethics Committee of Kerman University of Medical Sciences (Ethic No. IR.KMU.REC.1399.004). Before the initiation of the study, informed consent was obtained from the patients. For the patients hospitalized in ICU and those who were in the last stage of the diseases, informed consent was obtained from their family.

Data analysis

The data were described using mean \pm Standard Deviation (SD), median, Interquartile Rang (IQR), frequency and 95% Confidence Interval (CI). Student's *t* test was run to compare the patients' age based on hypertension, antihypertensive medication, and RAAS medication status. Other quantitative variables such as hospital stay and laboratory findings were assessed with Mann–Whitney *U* test. The qualitative variables were compared using the Fisher exact test. SPSS software version 23 was used for data analysis. Two-sided *P*-values less than 0.05 were considered statistically significant.

RESULTS

Baseline characteristics of patients with COVID-19

In the present study, 265 patients with COVID-19 were studied for hypertension status. The mean \pm SD age of the patients was 53.28 ± 19.45 years. More than half of the patients were males ($n = 159$, 60%). The history of cigarette smoking and opium addiction were low among the patients ($n = 18$, 6.8%, and $n = 42$, 15.8%, respectively). More than one-third of the patients had not any comorbidity ($n = 96$, 36.2%) but others had at least one comorbidity. The most prevalent comorbidity among the patients with COVID-19 was hypertension ($n = 68$, 25.7%, 95% CI: 20.8–31.3) (Fig. 2).

Hypertensive patients and control group

To compare the demographic and clinical information and laboratory findings of the patients with and without hypertension, a convenience sample of patients without any comorbidity were selected as the control group. The results of the study showed that the patients with hypertension were older than those in the control group (62.00 ± 15.26 vs. 54.67 ± 14.64 ; *P*-value: 0.03). Other demographic information was similar between the two groups. There was not any significant difference in medical information between the two groups. The assessment of the laboratory findings indicated the oxygen saturation was higher for the patients in the control group than hypertensive patients (90.00 (86.25–93.00) vs. 87.00 (80.50–90.00); *P*-value: 0.01). However, the CRP, LDH, and AST were lower for the patients in the control group compared to the hypertensive patients (Table 1).

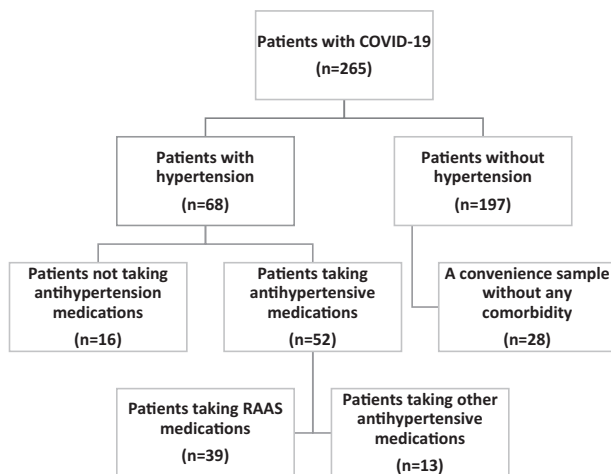


Fig. 1 The flow diagram of the patients' allocation. Patients were allocated based on hypertension status in the first phase and then the status of taking antihypertensive medications was considered. In the last phase, the type of antihypertensive medications were important.

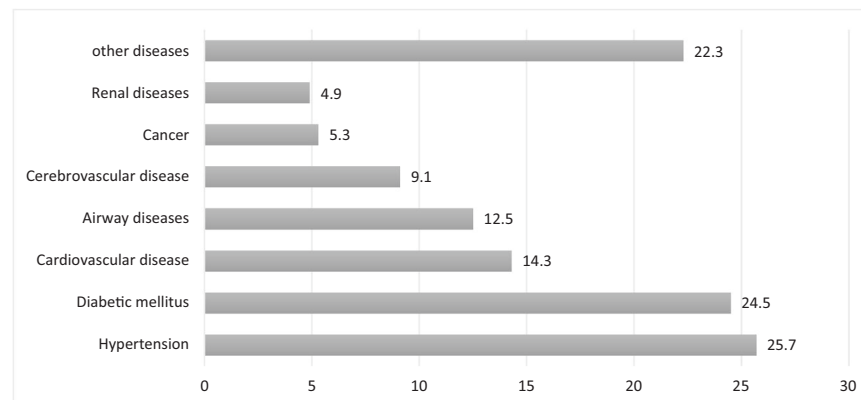


Fig. 2 The frequency of comorbidities among the patients admitted for COVID-19. Some of the patients reported more than a comorbidity.

Table 1. A comparison of the demographic, clinical, and laboratory findings between the hypertensive patients and control group.

Variables		Patients with hypertension (n = 68)	Patients without hypertension (n = 28)	P-value
Demographic information				
Age, (mean ± SD)		62.00 ± 15.26	54.67 ± 14.64	0.03
Sex, (%)	Male	39 (57.4)	17 (60.7)	0.76
	Female	29 (42.6)	11 (39.3)	
Opium consumption, (%)	Negative	57 (83.8)	20 (71.4)	0.16
	Positive	11 (16.2)	8 (28.6)	
Cigarette smoking, (%)	Negative	66 (97.1)	24 (85.7)	0.06
	Positive	2 (2.9)	4 (14.3)	
Clinical information				
Hospital stay, (Median (IQR))		7 (5–9.75)	7 (5–7.75)	0.10
ICU admission, (%)	Negative	55 (80.9)	24 (85.7)	0.77
	Positive	13 (19.1)	4 (14.3)	
Disease severity, (%)	Not severe	7 (10.3)	6 (21.4)	0.19
	Severe	61 (89.7)	22 (78.6)	
Invasive medical ventilation, (%)	Negative	58 (85.3)	24 (85.7)	>0.99
	Positive	10 (14.7)	4 (14.3)	
Final outcome, (%)	Discharge	55 (80.9)	25 (89.3)	0.38
	Death	13 (19.1)	3 (10.7)	
Laboratory findings				
SaO ₂ , (Median (IQR))		87.00 (80.50–90.00)	90.00 (86.25–93.00)	0.01
WBC, ×10 ⁹ /L, (Median (IQR))		7.65 (4.72–7.81)	7.81 (5.97–7.87)	0.10
HB, g/L, (Median (IQR))		12.59 (11.35–13.47)	12.59 (12.59–14.80)	0.12
PLT, (Median (IQR))		223.86 (174.25–249.75)	223.86 (195.25–230.71)	0.69
Urea, (Median (IQR))		45.61 (32.50–53.75)	45.61 (40.50–45.61)	0.91
CR, mg/L, (Median (IQR))		1.20 (0.82–1.58)	1.10 (0.90–1.55)	0.44
ESR, mm/h, (Median (IQR))		43.30 (28.25–59.00)	43.40 (31.00–43.40)	0.16
CRP, (Median (IQR))		41.55 (22.10–80.00)	18.50 (4.70–41.55)	0.002
LDH, U/L, (Median (IQR))		432.76 (404.25–504.75)	432.76 (391.00–432.76)	0.01
AST, U/L, (Median (IQR))		43.80 (30.00–47.00)	34.50 (21.25–43.80)	0.01
ALT, U/L, (Median (IQR))		35.75 (27.00–71.00)	35.37 (22.25–35.75)	0.07
BS, (Median (IQR))		136.00 (106.00–180.75)	161.64 (103.50–161.64)	0.74

SD standard deviation, IQR interquartile range, ICU intensive care unit, SaO₂ arterial oxygen saturation, WBC white blood cell, HB hemoglobin, PLT platelets, CR creatinine, ESR erythrocyte sedimentation rate, CRP C-reactive protein, LDH lactate dehydrogenase, AST aspartate aminotransferase, ALT alanine aminotransferase, BS blood sugar.

Statistically significant *p*-values are in bold.

Hypertensive patients with and without antihypertensive medications

According to the findings, more than three-quarters of hypertensive patients used antihypertensive medications (*n* = 52, 76.5%). Losartan and Amlodipine were frequent antihypertensive medications taken by the patients with hypertension (Fig. 3). The demographic and clinical data of hypertensive patients were similar in terms of antihypertensive medications taken, but some of the laboratory findings were significantly different between them, such as hemoglobin and LDH. Our findings showed that HB was higher for the patients who took antihypertensive medications than those who did not take these medications (12.59 (11.85–13.72) vs. 11.90 (10.62–12.82); *P*-value: 0.04). However, LDH was higher for the patients without antihypertensive medication (509.00 (432.76–728.75) vs. 432.76 (392.75–442.69); *P*-value: 0.009) (Table 2).

Hypertensive patients with and without RAAS medications

The findings of the study showed that the hypertensive patients who took RAAS medications for controlling their blood pressure were older than other hypertensive patients who did not take other

antihypertensive medications (63.39 ± 14.17 vs. 54.07 ± 14.47; *P*-value: 0.04). Other demographic and clinical data and also laboratory findings were not statistically different between the hypertensive patients based on the type of antihypertensive medications (Table 3).

DISCUSSION

The outcomes of patients with COVID-19 were related to some factors and recent studies revealed that patients with chronic diseases such as cardiac diseases, hypertension, and diabetes mellitus (DM) are at higher risk for severe COVID-19. The results of the present study showed that hypertension was a prevalent comorbidity among patients with COVID-19 and hypertensive patients compared to other patients without any comorbidity who were older. The saturated oxygen for hypertensive patients was lower than other patients, but some laboratory indexes such as CRP, LDH, and AST were higher among hypertensive patients. The results also showed that the hypertensive patients who took antihypertensive medications had higher HB and lower LDH compared to other hypertensive patients. The severity of

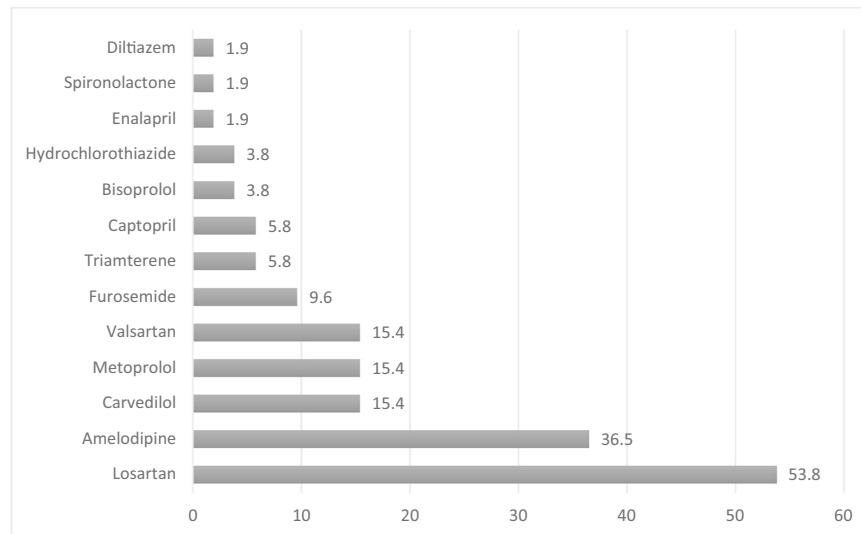


Fig. 3 The frequency of antihypertensive medications taken by the patients. Some of patients reported more than one medication.

COVID-19 and its outcome were not different between the patients who took or did not take antihypertensive medications and also the type of antihypertensive medications.

Recent studies have shown that the prevalence of hypertension among patients with COVID-19 is considerable. One study in china showed that more than one-quarter of patients with COVID-19 pneumonia had hypertension or took antihypertensive medications [3]. Another study showed that almost one-third of patients had hypertension [15]. According to recent studies, the prevalence of hypertension among patients with COVID-19 varied from 9.6% to 40.8% [16]. The results of the present study showed that more than 25% of patients with COVID-19 had hypertension and this result was in line with the mentioned studies. Hypertension is a chronic disease that typically occurs in middle-age individuals. The mean age of patients in the first peak of COVID-19 in the present study and also related studies can justify the considerable prevalence of hypertension among patients with COVID-19. According to our findings, the patients with hypertension were older than other patients without hypertension. This finding was also confirmed by other studies [3, 17].

One of the important findings of the present study was the difference in oxygen saturation among the patients with and without hypertension. The results revealed that the patients with hypertension had significantly lower oxygen saturation compared to the patients without hypertension. This finding was in line with other studies including Huang et al. [18]. and Okey et al. [19]. Furthermore, Jiang Xie et al. found that a significant number of patients with lower oxygen saturation (<90%) were suffering from hypertension [20]. There are limited studies on the relationship between hypertension and arterial oxygen saturation especially among patients treated for COVID-19. The important matter is the correlation between oxygen saturation and patients' age [21]. In fact, the respiratory volume and lung capacity of humans are altered by aging-related changes, and the presence of some chronic lung diseases such as fibrosis and chronic obstructive pulmonary disease can intensify this problem [22]. Therefore, the lower level of oxygen saturation among patients with hypertension was more likely to be associated with the patients' age than the presence of hypertension.

The present study showed that some inflammatory markers such as C-Reactive Protein (CRP), Lactate-Dehydrogenase (LDH), and Aspartate aminotransferase (AST) were higher among the hypertensive patients with COVID-19 compared to normotensive patients. Another study showed different levels of AST and CRP between hypertensive and normotensive patients [23]. Okey et al.

revealed that hypertensive patients with COVID-19 had a higher level of these inflammatory markers than normotensive patients with COVID-19 [19]. According to the previous studies, hypertension is assumed as an inflammatory disorder in which CRP levels were associated with future development of hypertension among healthy individuals [23, 24].

Other plasma markers of liver injury such as AST, LDH, and ALP were higher among hypertension patients than healthy people [23]. Bautista et al. [25] found that CRP was similar between hypertensive and normotensive subjects. These controversial findings justify the need for further studies in this field. Plasma inflammatory markers and also blood pressure are the variables that change day to day in any person and many factors affect them including sex. Another important factor is the simultaneous existence of COVID-19 and hypertension which need more attention. Based on the results of the present study, LDH was lower for hypertensive patients who took antihypertensive medications but the type of antihypertensive medications did not play a role in inflammatory markers, which was in line with recent studies [26, 27]. The present study also showed that the serum level of LDH was similar between healthy people and the patients who took Captopril as antihypertensive medication [28]. There was no significant difference in plasma inflammatory markers and type of antihypertensive medications in the present study.

The results of various studies have shown a link between values of blood factors with high blood pressure [29–31] and COVID-19 [32]. Meanwhile, these factors can be considered as predictors of hypertension [33] or severity of COVID-19 [34]. Among these, we can mention the inflammatory factors such as C-reactive protein (CRP) that have been shown to be associated with both hypertension and COVID-19 disease [35–37]. Likewise, previous studies have revealed that hemoglobin is significantly associated with blood pressure and by increasing the level of hemoglobin, both systolic and diastolic blood pressure levels increase regardless of the sex of healthy persons [38, 39]. However, another study observed this relationship only among women [40]. In the present study, hemoglobin level among hypertensive and normotensive patients was similar, but it was significantly higher among the hypertensive patients who used antihypertensive medications than other hypertensive patients who did not take any antihypertensive medications and the type of antihypertensive medications did not play any role in the level of hemoglobin. While some studies have rejected these findings and have shown that patients who took

Table 2. A comparison of demographic, clinical, and laboratory findings between hypertensive patients based on antihypertensive medications.

Variables		Patients taking antihypertensive medication (n = 52)	Patients not taking antihypertensive medications (n = 16)	P-value
Demographic information				
Age, (mean ± SD)		61.28 ± 14.72	64.31 ± 17.23	0.49
Sex, (%)	Male	31 (59.6)	8 (50)	0.49
	Female	21 (40.4)	8 (50)	
Opium consumption, (%)	Negative	43 (82.7)	14 (87.5)	>0.99
	Positive	9 (17.3)	2 (12.5)	
Cigarette smoking, (%)	Negative	50 (96.2)	16 (100)	>0.99
	Positive	2 (3.8)	0	
Comorbidity, (%)	0	1 (1.9)	1 (6.3)	0.34
	1–2	27 (51.9)	6 (37.5)	
	≥3	24 (46.2)	9 (56.3)	
Clinical information				
Hospital stay, (Median (IQR))		7 (5.00–9.75)	5.50 (4.00–10.50)	0.33
ICU admission, (%)	Negative	42 (80.8)	13 (81.3)	>0.99
	Positive	10 (19.2)	3 (18.8)	
Disease severity, (%)	Not severe	6 (11.5)	1 (6.3)	>0.99
	Severe	46 (88.5)	15 (93.8)	
Invasive medical ventilation, (%)	Negative	44 (84.6)	14 (87.5)	>0.99
	Positive	8 (15.4)	2 (12.5)	
Final outcome, (%)	Discharge	42 (80.8)	13 (81.3)	>0.99
	Death	10 (19.2)	3 (18.8)	
Laboratory findings				
SaO ₂ , (Median (IQR))		87.00 (83.00–90.00)	85.50 (76.00–88.75)	0.33
WBC, ×10 ⁹ /L, (Median (IQR))		7.55 (4.70–7.81)	7.65 (5.65–8.22)	0.53
HB, g/L, (Median (IQR))		12.59 (11.85–13.72)	11.90 (10.62–12.82)	0.04
PLT, (Median (IQR))		223.86 (181.50–246.25)	201.93 (149.50–264.50)	0.53
UREA, (Median (IQR))		45.61 (31.25–45.61)	45.61 (36.00–59.25)	0.41
CR, mg/L, (Median (IQR))		1.20 (0.82–1.60)	1.15 (0.82–1.51)	0.85
ESR, mm/h, (Median (IQR))		43.40 (23.00–53.50)	48.00 (43.40–74.50)	0.07
CRP, (Median (IQR))		41.55 (18.50–73.00)	50.85 (38.13–96.50)	0.10
LDH, U/L, (Median (IQR))		432.76 (392.75–442.69)	509.00 (432.76–728.75)	0.009
AST, U/L, (Median (IQR))		43.80 (30.00–46.25)	43.80 (30.00–70.00)	0.66
ALT, U/L, (Median (IQR))		35.75 (27.00–39.00)	35.75 (22.00–62.50)	0.75
BS, (Median (IQR))		138.50 (106.50–182.75)	131.00 (96.50–165.66)	0.57

SD standard deviation, IQR interquartile range, ICU intensive care unit, SaO₂ arterial oxygen saturation, WBC white blood cell, HB hemoglobin, PLT platelets, CR creatinine, ESR erythrocyte sedimentation rate, CRP C-reactive protein, LDH lactate dehydrogenase, AST aspartate aminotransferase, ALT alanine aminotransferase, BS blood sugar.

Statistically significant *p*-values are in bold.

antihypertensive medications had a lower level of hemoglobin [41]. Another study found that the type of antihypertensive medications affected the level of hemoglobin among hypertensive patients with type 2 diabetes mellitus [42]. One study revealed that ACEis lead to a decrease in hemoglobin level while patients who used ARB had stable hemoglobin during different time intervals [43]. These results were in contrast with the findings observed in the present study. Since the mechanism underlying the effect of antihypertensive medications on hemoglobin level is still unknown, more studies need to address this issue especially among patients affected with COVID-19.

The main finding of our study was this observation that using RAAS medications currently or previously was not associated with severity and the outcome of COVID-19 and the type of antihypertensive medications did not alter the outcome of patients. This result was in line with related studies [27, 44, 45].

In contrast, some studies revealed that using ACEi/ARB was associated with a lower mortality rate. For example, the study conducted by Negreira-Caamaño et al in Spain on 545 patients with hypertension and COVID-19 showed that using ACEi or ARB medications leads to lower all-cause death among hypertensive patients who were hospitalized for COVID-19 [46]. Another study by Genet et al. in France on 201 patients with COVID-19 revealed that patients taking ACEi/ARB medications before the onset of the coronavirus infection had better outcomes such as lower mortality rate. But this finding only applies to elderly patients [47]. These conflicting results, in addition to differences in study populations, goals, and study time, may be due to our lack of knowledge about COVID-19, all of which seek to uncover more information about this disease.

In addition to all that, it is worth mentioning the current status of blood pressure management and the main goals of this health

Table 3. A comparison of demographic, clinical, and laboratory findings between hypertensive patients based on the type of antihypertensive medications.

Variables		Patients with RAAS medication (n = 39)	Patients with other antihypertensive medications (n = 13)	P-value
Demographic information				
Age, (mean ± SD)		63.39 ± 14.17	54.07 ± 14.47	0.04
Sex, (%)	Male	25 (64.1)	6 (46.2)	0.25
	Female	14 (35.9)	7 (53.8)	
Opium consumption, (%)	Negative	30 (76.9)	13 (100)	0.09
	Positive	9 (23.1)	0	
Cigarette smoking, (%)	Negative	38 (97.4)	12 (92.3)	0.44
	Positive	1 (2.6)	1 (7.7)	
Comorbidity, (%)	0	0	1 (7.7)	0.26
	1–2	20 (51.3)	7 (53.8)	
	≥3	19 (48.7)	5 (38.5)	
Clinical information				
Hospital stay, (Median (IQR))		7.00 (5.00–9.00)	8.00 (5.00–10.00)	0.45
ICU admission, (%)	Negative	32 (82.1)	10 (76.9)	0.69
	Positive	7 (17.9)	3 (23.1)	
Disease severity, (%)	Not severe	6 (15.4)	0	0.31
	Severe	33 (84.6)	13 (100)	
Invasive medical ventilation, (%)	Negative	33 (84.6)	11 (84.6)	>0.99
	Positive	6 (15.4)	2 (15.4)	
Final outcome, (%)	Discharge	32 (82.1)	10 (76.9)	0.69
	Death	7 (17.9)	3 (23.1)	
Laboratory findings				
SaO ₂ , (Median (IQR))		87.00 (83.00–90.00)	85.00 (77.00–89.00)	0.17
WBC, ×10 ⁹ /L, (Median (IQR))		7.30 (4.70–7.81)	7.81 (4.50–7.81)	0.94
HB, g/L, (Median (IQR))		12.59 (12.00–14.10)	12.59 (11.20–12.59)	0.22
PLT, (Median (IQR))		223.86 (160.00–238.00)	223.86 (206.43–299.00)	0.27
UREA, (Median (IQR))		45.61 (30.00–45.61)	45.61 (37.50–58.80)	0.32
CR, mg/L, (Median (IQR))		1.10 (0.90–1.55)	1.40 (0.70–2.25)	0.44
ESR, mm/h, (Median (IQR))		43.40 (22.00–54.00)	43.40 (37.50–54.50)	0.64
CRP, (Median (IQR))		41.55 (20.00–78.00)	41.55 (12.60–46.27)	0.43
LDH, U/L, (Median (IQR))		432.76 (391.00–451.00)	432.76 (398.88–432.76)	0.87
AST, U/L, (Median (IQR))		43.80 (30.00–47.00)	43.80 (29.50–43.80)	0.69
ALT, U/L, (Median (IQR))		35.75 (27.00–41.00)	35.75 (31.37–37.00)	0.81
BS, (Median (IQR))		142.00 (109.00–215.00)	120.00 (94.00–161.64)	0.13

SD standard deviation, IQR interquartile range, ICU intensive care unit, SaO₂ arterial oxygen saturation, WBC white blood cell, HB hemoglobin, PLT platelets, CR creatinine, ESR erythrocyte sedimentation rate, CRP C-reactive protein, LDH lactate dehydrogenase, AST aspartate aminotransferase, ALT alanine aminotransferase, BS Blood Sugar.

Statistically significant *p*-values are in bold.

problem. More than one billion people aged 30–79 have hypertension in the world and 21% of them have it under control [48]. About 50% of people with hypertension were never diagnosed or received the necessary treatment and the uncontrolled hypertension is a serious threat to health [49]. Although the status of high blood pressure management in Iran has improved and it is better than in some developing countries [50], its trend is still increasing [51] and needs more effective interventions and curative strategies [52, 53].

This study has a major limitation which related to sample size of study. Although the present study provides valuable information for policymaking, it has very serious limitation of small sample size, so researchers should pay attention to this important point in generalizing these results.

CONCLUSION

The results of the present study showed that hypertensive patients who used different types of antihypertensive medications did not show any significant difference in survival, hospital stay, ICU admission, disease severity, and invasive medical ventilation as an important clinical outcome in other normotensive patients with COVID-19. Based on the results, prescribing antihypertensive medication to all patients with COVID-19 to improve the clinical profile of COVID-19 may not lead to desired outcomes. However, conflicting results reported in different studies with different sample sizes and also different study designs warrant the need for future well-designed studies to identify the role of antihypertensive medications for normotensive patients with COVID-19 or all patients with COVID-19.

SUMMARY TABLE

What is known about topic

- Hypertensive patients with COVID-19 are at a greater risk of ICU admission and low survival.
- Antihypertensive medications that control the ACE or the receptor blocker of this enzyme may prevent severe COVID-19 in patients with high blood pressure.

What this study adds

- Hypertensive patients with different types of antihypertensive medications was similar in COVID-19 severity like other normotensive patients.
- Prescribing antihypertensive medication to all patients with COVID-19 to improve the clinical profile of COVID-19 may not lead to desired outcomes.

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COMPETING INTERESTS

The authors declare no competing interests.

ADDITIONAL INFORMATION

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