OPEN ACCESS Freely available online

Family Medicine and Medical Science Research

Research Article

The Effects of Co-morbidities on COVID-19 Patients Admitted to the Hospital

Ali Zaenab, MD*, Velasquez Jose, MD, Chen-Joea Cynthia, DO, MPH, Zaveri Yousuf, MD, Martin Claudia, MD, Shalikar Hamed, MD

Department of Family Medicine, Emanate Health Family Medicine Residency Program, USA

ABSTRACT

Background: To investigate hospital length of stay (LOS), intensive care unit admission (ICU) and duration, use of mechanical ventilation, and outcomes (death or discharge) in hospitalized patients with confirmed COVID-19 and pre-existing co-morbidities.

Methods: This is a retrospective cohort study of 271 consecutive patients with COVID-19 evaluated at the three Emanate Health hospitals located in Southern California for a three-month period from April 1, 2020, to June 30, 2020.

Exposures: Patients with laboratory-confirmed SARS-CoV-2 infection by positive result on the reverse transcriptase polymerase chain reaction testing. Data was electronically and manually extracted from the electronic medical records system and cross-referenced for confirmation. Data collected included all adult patients admitted with and without underlying medical conditions. No patients were excluded.

Main Outcomes and Measures: Clinical outcomes including length of stay (LOS), ICU admission and LOS, need for mechanical ventilation and mortality were measured and a 2-way ANOVA analysis was performed using GraphPad Prism software version 8.4.3.

Results: A total of 271 patients were included, during hospitalization 28.8% were admitted to ICU, 19.9% required mechanical ventilation, 19.5% passed, and 21% were discharged to an alternative facility. The most prevalent comorbidity was hypertension 61.9%, followed by diabetes 46.1%, obesity 40.5%, coronary artery disease 13.2%, atrial fibrillation 11.4%, CHF 9.9%, COPD 9.9%, and asthma 1.4%. ABO was determined for 57.5% of patients.

Conclusion: Two-thirds of patients admitted to the hospital had at least one underlying comorbidity, having more than one pre-existing comorbidity correlated with a more complicated hospital course and worse outcome.

Keywords: COVID-19; Comorbidity; Hypertension; Diabetes; Obesity; COPD; Asthma; Cardiovascular disease; risk; ANOVA analysis

Abbreviations: COVID-19: Coronavirus Disease 2019; HTN: Hypertension; DM: Diabetes Mellitus; BMI: Body Mass Index; CVD: Cardiovascular Disease; COPD: Chronic Obstructive Pulmonary Disease; ICU: Intensive Care Unit; LOS: Length of Stay

INTRODUCTION

As of December 8, 2020, the CDC reported more than 14.8 million confirmed cases of the Coronavirus Disease 2019 (COVID-19) and 282,785 COVID-19 related deaths were reported in the United States [1]. The first confirmed case of COVID-19 in the state of California was reported from Orange County. The California Department of Public Health has reported 956,957 confirmed cases and 17,939 related deaths on November 7th, California now has the highest number of confirmed cases in the United States. Published studies since the COVID-19 outbreak in December 2019 investigated the effects of pre-existing comorbidities and the impact on COVID-19 patient's prognosis and outcome. Studies have shown strong evidence that patients with a history of hypertension, obesity, chronic obstructive pulmonary disease, diabetes, and cardiovascular disease had poor prognosis and most often end up

***Correspondence to** Ali Zaenab, Department of Family Medicine, Emanate Health Family Medicine Residency Program, USA, Tel: +16268137837; E-mail: zaenab.m.ali@gmail.com

Received: December 16, 2020; **Accepted:** February 19, 2021; **Published:** February 26, 2021

Citation: Zaenab A, Jose V, Cynthia CJ, Yousuf Z, Claudia M, Hamed S (2021) The Effects of Co-morbidities on COVID-19 Patients Admitted to the Hospital. Fam Med Med Sci Res 10:2. doi: 10.35248/2327-4972.21.10.261.

with deteriorating outcomes such as Acute Respiratory Distress Syndrome (ARDS) and pneumonia requiring hospitalization, intensive care unit admission, mechanical ventilation, and an increase in the risk of long term morbidity and mortality [2,3]. Hypertension and Cardiovascular disease has been widely reported increasing the risk of morbidity and mortality in COVID-19 patients. COVID-19 is a serious disease with worse outcomes for those with underlying medical conditions.

Patients with diabetes are more likely to experience severe symptoms and complications whenever infected with any type of respiratory virus, and this trend may follow with COVID-19. The risk of getting more ill from COVID-19 may be higher with uncontrolled diabetes. In general, More than 80% of patients with diabetes are obese or overweight adding to the risk of developing severe symptoms of COVID-19 infection [4]. Obesity is a well known risk factor for respiratory tract infections such as pneumonia, in this study we stratified the severity, outcomes and impact of coronavirus infection on different Body Mass Index (BMI) categories. Further data is required to determine the risk of COVID-19 severity and outcomes across all BMI categories and in those with prediabetes to provide clear guidance and inform patient care.

Studies are limited on the long-term effects of COVID-19 among patients with pre-existing respiratory diseases, such as COPD and asthma. Chronic obstructive pulmonary disease patients are generally more susceptible to virus-induced exacerbations, compromised pulmonary function and have higher prevalence of associated comorbidities. We also investigated the relationship between blood group and clinical outcomes in patients with COVID-19, some recent studies reported that patients with type O blood are at a lower risk of being infected with COVID-19, whereas those with type A blood are at higher risk [5]. Data from the severe acute respiratory syndrome coronavirus (SARS-CoV-1) outbreak in 2003, suggested that healthcare workers with type O blood were less likely to contract the coronavirus disease [6,7].

In this retrospective cohort study we present details of all patients admitted to Emanate Health with confirmed COVID-19. We aim to investigate the impact of COVID-19 on patients with baseline comorbidities and evaluate the risk of serious adverse outcomes in this patient's population by stratification according to the type of comorbidity, subsequently revealing the sub-populations with poorer prognosis and the factors associated with hospital stay, the need for intensive care and death in COVID-19 patients with comorbidities.

METHODS

The study was conducted at Emanate Health in the cities of Covina and West Covina, the largest nonprofit health care institution serving the San Gabriel Valley in California. Data collected included 271 consecutive patients with confirmed severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) infection by positive result on polymerase chain reaction testing of nasopharyngeal samples. Patients were admitted to any of the three Emanate Health acute hospitals between April 1, 2020, and June 30, 2020. Clinical outcomes were monitored until June 30, 2020, the final date of the study.

Data was collected utilizing the Meditech Expanse electronic health record database and statistical analysis was conducted with GraphPad Prism software version 8.4.3. Data collected included comorbidities sorted according to the system involved, subsequently divided into subgroups to facilitate the analysis. These subgroups were later compared based on hospital LOS, ICU admission and ICU LOS, number of patients expired, number of patients discharged and mortality rate. A 2-way ANOVA analysis was performed with an alpha error of 0.05% and a p value of less than 0.05 was considered statistically significant.

Data was electronically and manually extracted from the electronic medical records system and cross-referenced for confirmation. Data collected was placed on an Excel spreadsheet and subsequently divided into groups based on the underlying medical condition. Furthermore, these groups are sub-grouped for comparison. Data included patients with hypertension, and diabetes from past medical history (self-reported at the time of admission or incidentally diagnosed with abnormal values of the HbA1C during hospital stay). Body mass index greater than or equal to 30 was a marker of obesity, all 271 patients had a recorded BMI. Data also included patients with cardiovascular disease such as coronary artery disease, congestive heart failure, and atrial fibrillation. Additionally, patients with chronic obstructive pulmonary disease and asthma as well as blood types were analysed.

RESULTS

Data analyzed were categorized based on the type of the comorbidity and blood type.

Hypertension

The most prevalent comorbidity among our patients population was hypertension (n=168) 61.9% (Table 1). The average hospital LOS for those with hypertension was 10.07 days. Non-hypertensive patients had a minimally higher hospital LOS in comparison to patients with hypertension (CI of 95% and P value 0.695). Patients with hypertension had a minimally higher LOS in the ICU in comparison to non-hypertensive patients (CI 95% and P value 0.5802), data was not adjusted to account for mortality. Patients with hypertension had a comparatively higher number of patients requiring ICU admission, mechanical ventilation and a higher mortality rate (CI 95% and P value 0.0669).

Diabetes Mellitus

Diabetes was the second most prevalent comorbidity (n=125) 46.1% (Table 2). The average hospital LOS among those admitted with diabetes was 10.7 days. Patients with diabetes had a higher hospital LOS in comparison to nondiabetic patients (CI of 95% P value 0.261). Patients with diabetes had a higher ICU LOS in comparison to nondiabetic patients (CI of 95% and P value 0.1918). Patients with diabetes demonstrated higher numbers of patients requiring ICU admission, mechanical ventilation and higher number of patients requiring alternative facilities admission as well as higher mortality rates in comparison to nondiabetic patients (CI 95% and P value 0.151).

Obesity

The total number of patients (N=271) was divided into three subgroups based on patients BMI [<25 (n1=69) 25.4%, 25-30 (n2= 92) 33.9% and>30 (n3=110) 40.5%] to facilitate the analysis (Table 3). Patients with lower BMI (<25) had a statistically significant longer hospital LOS than patients with higher BMI (CI of 95% and P value 0.048), likely related to the fact that patients with higher BMI had a higher ICU stay and higher mortality in our patient's

Table 1: Hospital course and outcome of COVID-19 patients with hypertension.

	HTN	Non HTN	Total
Cases (#)	168	103	271
AVG hospital stay (d)	10	10	10.2
ICU stay (#)	51	29	80
PTS on ventilator (#)	38	16	54
Expired (#)	37	16	53
Mortality Rate (%)	13.6	5.9	19.5
PTS not discharged home (#)	44	13	57

Table 2: Hospital course and outcome of COVID-19 patients with diabetes.

	DM	Non DM	Total
Cases (#)	125	146	271
AVG hospital stay (d)	10.7	9.7	10.2
ICU stay (#)	50	30	80
PTS on ventilator (#)	33	21	54
Expired (#)	35	18	53
Mortality rate (%)	12.9	6.6	19.5
PTS not discharged home (#)	31	26	57

Table 3: Hospital course and outcome of COVID-19 patients based on different BMI categories.

	BMI <25	BMI 25-30	BMI >30	Total
Cases (#) n	69	92	110	271
AVG hospital stay (d)	11.6	8.7	12	10.2
ICU stay (#)	19	25	37	81
PTS on ventilator (#)	11	18	25	53
Expired (#)	16	17	20	53
Mortality rate (%)	5.9	6.2	7.3	19.5
PTS not discharged home (#)	30	17	10	57

population. Patients with higher BMI had a higher ICU admission and LOS but did not reach a statistical significance in our analysis (CI 95% and P value 0.107). Patients with higher BMI had a high number of patients requiring invasive mechanical ventilation and a higher mortality rate in comparison to patients with lower BMI although not statistically significant (CI and P value 0.537).

Cardiovascular Disease

The most prevalent cardiovascular disease among our patients population was coronary artery disease (n=39) 14.3%, followed by atrial fibrillation (n=31) 11.4% and congestive heart failure (n=27) 9.9% (Table 4). Patients with atrial fibrillation had a significantly higher LOS followed by coronary artery disease, and congestive heart failure (CI of 95% and P value 0.054). Patients with Afib had a comparatively higher LOS in the ICU followed by CAD, CHF and angina (CI of 95% and P value 0.072). Patients with CAD had significantly higher numbers of patients requiring ICU admission, mechanical ventilation, and a higher mortality rate as well as higher numbers of patients discharged to alternative facilities (CI of 95% and P<0.0077). Cardiovascular mortality was similar in CAD and Afib, followed by CHF.

Chronic Obstructive Pulmonary Disease and Asthma

COPD patients account for (n=27) 9.9%, and asthma patients (n=4) 1.4% among our patients population (Table 5). Patients with COPD had a statistically significant higher LOS in comparison to patients with asthma (CI 95% and P value<0.0049). Patients with COPD had a comparatively higher ICU LOS compared to patients with asthma, however this comparison was not statistically significant (CI 95% and P value 0.226). COPD patients had a higher number of patients requiring ICU admission, invasive mechanical ventilation and discharge to alternative facilities as well as higher mortality rate when compared to asthma patients, although it was not statistically significant in our analysis (CI 95% and P value 0.405).

ABO Blood Groups

Blood groups were determined for (N=156) 57.5% of patients, the most prevalent blood type among those with a known ABO was O positive blood group (n=88) 56.4%, followed by A positive (n=35) 22.4%, B positive (n=18) 11.5%, O negative (n=6) 3.8%, AB positive (n=4) 2.5%, A negative (n=3) 1.9%, and B negative (n=2) 1.2% (Table 6). LOS was significantly higher in the O negative and A negative blood types when compared to other blood groups. Those with B negative blood type had a significantly lower LOS when compared to other blood groups (CI 95% and a P value of <0.0001). Those with O negative and A negative blood types had a comparatively higher ICU stay in comparison to the other blood groups (CI 95% and P value of<0.0001). The comparative number of patients requiring ICU admission, mechanical ventilation and discharge to alternative facilities did not reach statistical significance (CI 95% and P value of <0.165). Mortality rate was higher in the O positive group, followed by A and B positive.

Table 4: Hospital course and outcome of COVID-19 patients with cardiovascular disease.

	CAD (14.3% Cases)	CHF (9.9% Cases)	Afib (11.4% cases)	Total
Cases (#)	39	27	31	271
AVG hospital stay (d)	10	10	12	10.2
ICU stay (#)	14	9	12	81
PTS on ventilator (#)	13	8	11	53
Expired (#)	13	7	11	53
Mortality rate (%)	4.79	3	4	19.5
PTS not discharged home (#)	21	11	14	57

Table 5: Hospital course and outcome of COVID-19 patients with COPD and asthma.

	COPD	Asthma	Total
Cases (#)	27	12	271
AVG hospital stay (d)	12.4	8.25	10.2
ICU stay (#)	9	5	81
PTS on ventilator (#)	7	0	53
Expired (#)	3	1	53
Mortality rate (%)	1	0.3	19.5
PTS not discharged home (#)	11	0	57

Table 6: Hospital course and outcome of COVID-19 patients based on different blood type.

	A+(12.9% Cases)	A-(1.1% Cases)	B+(6.6% Cases)	B-(0.7% Cases)	O+(32.4% Cases)	O-(2.2% Cases)	AB+(1.4% CASES)	Undetermined ABO(42.4% Cases)	Total
Cases(#)	35	3	18	2	88	6	4	115	271
AVG hospital stay (d)	12	19	14	6	11	20	10	8	10.2
ICU stay (#)	12	1	7	0	35	3	1	21	81
PTS on ventilator (#)	9	1	6	0	24	3	0	11	53
Expired (#)	8	0	5	1	23	2	1	13	53
Mortality rate (%)	3	0	2	0.3	8	0.7	0.3	4.7	19.5
PTS not discharged home (#)	6	0	5	1	13	1	3	28	57

DISCUSSION

The novel coronavirus pandemic causing COVID-19 has led to more than 68 million confirmed cases and 1.5 million deaths worldwide as of December 9, 2020. It has been reported that it can range from mild cold like symptoms to severe Acute Respiratory Distress Syndrome (ARDS), multi-organ failure, and even death. Hypertension (15.8%) is the most common comorbidity followed by cardiovascular and cerebrovascular conditions (11.7%). It is believed that 80% of the patients will recover from the acute disease without any treatment, and 20% of cases will require a higher level of care for treatment [8]. It is well described that the risk of developing a severe disease increases with age, with the greatest risk amongst those older than 85 years old according to the National Center for Health Statistics. Per CDC database, 8 out of 10 deaths reported in adults have been from adults 65 years and older [9].

Previous studies have suggested that infection with COVID-19 in those with underlying medical conditions increases the risk for ICU admission, prolonged hospital LOS, and the requirement for invasive mechanical ventilation [10]. In our patient population, hypertension was the most prevalent comorbidity (61.9%), which is a finding also demonstrated by other studies [3,11,12]. Studies from Wuhan [4,13] Lombardy [14], and New York City [4], identified higher rates of hypertension amongst hospitalized COVID-19 patients. A large study conducted in the New York City area of 5,700 hospitalized patients revealed a hypertension rate of 56%, almost similar to the hypertension rates reported by China 50% [15] and Italy 49% [14]. The link between hypertension and COVID-19 remains unclear. In general, hypertension is more prevalent in elderly individuals, the risk of contracting COVID-19 increases with the older age population, who are also more likely to develop severe symptoms when infected by the coronavirus [16,17]. The high numbers of reported hypertension amongst hospitalized COVID-19 patients could be confounded by age and other associated comorbidities like diabetes, obesity, cardiovascular disease, COPD, and chronic kidney disease. In our study we investigated hospital LOS, ICU admission and ICU LOS in hospitalized COVID-19 patients and how it is influenced by the different underlying medical conditions. As reported by previous studies hypertension carries nearly 2.5 fold higher risk of developing severe COVID-19 and even death by SARS-CoV-2 infection [18-21].

There are multiple factors to consider when it comes to the severity of COVID-19 observed in those with an underlying comorbidity of hypertension, some researchers argue about the effect of antihypertensive medications such as ACE inhibitors and ARBs on the development of severe symptoms. Interestingly, ACE inhibitors and ARBs antihypertensive medications may lead to over expression of ACE2 receptors, which is used by the SARS-CoV-2 to gain entrance into the cell, ultimately leading to a higher viral load [18]. Another factor to take into consideration

is that hypertensive patients are usually older in age and may have other associated comorbidities or cardiovascular disease which would ultimately translate into a higher risk of adverse local or systemic consequences of COVID-19 [20,21]. We observed in our study that there was a correlation between hypertensive patients and the higher numbers of patients requiring ICU admission, invasive mechanical ventilation and discharge to alternative facilities in comparison to non-hypertensive patients. Patients with hypertension demonstrated a prolonged ICU length of stay, whereas patients without hypertension demonstrated a minimally higher hospital LOS, likely due to the higher mortality rate observed among those with hypertension, another possibility is the higher number of patients in the hypertensive group when compared to non-hypertensives and the disproportionate sample sizes (Table 1). Mortality rates were more than 2-fold higher in hypertensive patients when compared to non-hypertensive. This comparison was trended towards statistical significance in our analysis. Another known risk factor for a complicated COVID-19 infection is having an underlying cardiovascular disease, researchers found an association between cardiovascular diseases and the increased fatal outcomes in COVID-19 patients especially in those with an underlying myocardial injury [19]. Patients with cardiovascular disease accounted for 35.7% of our patients population. We observed a significantly higher hospital LOS and ICU length of stay in those with atrial fibrillation in comparison to patients with other cardiovascular diseases (Table 4). While, patients with CAD had significantly higher numbers of patients requiring ICU admission, mechanical ventilation, and a higher number of patients requiring alternative facilities discharge. Mortality rate was similar among patients with CAD and Afib.

Diabetes is the second most common comorbidity in our patients population (46.1%), having diabetes especially poorly controlled diabetes increases the risk of developing severe symptoms, requiring ICU admission and invasive mechanical ventilation as well as an increase in mortality rate when infected by COVID-19. In general, patients with diabetes are more susceptible for infection, including with respiratory viruses such as Influenza A virus, Severe Acute Respiratory Syndrome (SARS) coronavirus and Middle East Respiratory Syndrome-related coronavirus (MERS-CoV) [22,23]. We observed in our study that patients with diabetes had a higher hospital LOS and ICU length of stay in comparison to nondiabetics. Patients with diabetes demonstrated higher numbers of patients requiring ICU admission, mechanical ventilation and higher numbers of alternative facility discharge, such as to a skilled nursing facility, when compared to nondiabetics (Table 2). Some recently published studies established an association between diabetic microvascular disease [24-26], the requirement for invasive mechanical ventilation and poor COVID-19 outcomes [27]. Several factors contribute to the development of severe adult respiratory distress syndrome in diabetic patients such as the impaired immune response, heightened inflammatory response and the associated cardiovascular disease [28-30]. A possible major contributor is the pre-existing endothelial dysfunction and microangiopathy in diabetic patients [26]. There was a 2-fold increase in mortality rate among diabetic patients in our population. However, our analysis did not reach statistical significance possibly due to the higher number of patients in the diabetic group when compared to nondiabetics and the disproportional sample sizes. Diabetes is generally associated with obesity, 80% of diabetic patients are overweight or obese, which in turn significantly increases the risk for hospitalization and death in COVID-19 patients [24,31-33]. In our patients population 40.5% were obese and 33.9% were considered overweight. Patients with lower BMI had a statistically significant longer hospital LOS than patients with higher BMI. Likely related to the fact that patients with higher BMI had a higher ICU stay and higher mortality rate. The BMI was directly proportional to the number of patients requiring ICU, ventilation and number of patients expired, and inversely proportional to the number of discharges (Table 3). However, this comparison did not reach statistical significance and is merely based on observation. Mortality rate was directly proportional to the BMI according to our data.

According to the CHEST Annual Meeting in 2020, COPD may be associated with lower COVID-19-related hospitalizations but higher mortality rates [34,36]. Some researchers observed that having a pre-existing asthma reduces the chances of contracting COVID-19, it is believed that respiratory allergies are associated with significant reductions in the expression of angiotensin-converting enzyme 2 receptors, which in turn may suggest that asthmatic patients may be less susceptible for COVID-19 infection [37,38]. In this study we observed that patients with COPD had a statistically significant higher hospital LOS in comparison to patients with asthma. Patients with COPD had a comparatively higher number of patients requiring ICU admission and mechanical ventilation compared to patients with asthma, however this comparison was not statistically significant (Table 5). More than 40% of COPD patients were discharged to alternative facilities, while none of the asthmatic patients were. Mortality rate was higher in the COPD group when compared with asthma.

Some researchers found an association between patients with group A blood type and their increased susceptibility for COVID-19 infection, whereas patients with group O blood type had a decreased risk for infection [6,39]. While others believe that there is no association between the different blood types and their susceptibility for COVID-19 infection or developing severe infections [40]. Some researchers also established an association between Rh+ blood groups and the possibility of testing positive for COVID-19, Patients with B and AB blood types were more likely to test positive as were those who are Rh+ positive, and O blood type was less likely to test positive [41]. In our patients population the most prevalent blood type was O positive blood type (32.4%), LOS was significantly higher in the O negative group compared to the other blood types. Those with B negative blood type had a statistically significant lower LOS when compared to other blood types (Table 6). Those with A and B negative blood types had a comparatively higher ICU stay compared to the other blood types, this comparison was statistically significant. The comparative number of patients requiring ICU, mechanical ventilation, mortality rate did not reach any statistical significance. Mortality rate was higher in the O positive group, followed by A and B positive. Likely corresponding to the number of cases (outlier).

CONCLUSION

To the best of our knowledge, this is the first case series investigating hospital length of stay, ICU admission and length of stay, and severity of COVID-19 infection as related to requirements for mechanical ventilation, alternative facility discharge, and death in relation to the different underlying comorbidities in hospitalized COVID-19 patients. In this study, hypertension was the most prevalent comorbidity followed by diabetes and obesity. We found that approximately two-thirds of patients admitted to the hospital with a confirmed COVID-19 had at least one underlying medical condition. Non-hypertensive patients had a minimally higher hospital LOS but may be due to the fact that

patients with underlying hypertension had a higher mortality rate and experienced a complicated course during hospitalization. Patients with hypertension had more than 2-fold higher mortality rate when compared to non-hypertensives. Patients with atrial fibrillation experienced more complications when compared to other cardiovascular diseases, such as prolonged hospital LOS, the requirement for ICU admission and mechanical ventilation. Patients with CAD and Afib had similar rates of mortality. Patients with diabetes were two times more likely to require ICU admission and experience a prolonged hospital and ICU LOS when compared to nondiabetics. Patients with diabetes had a 2-fold higher mortality rate in comparison to nondiabetics. Patients with lower BMI had a higher hospital LOS when compared to higher BMI, this is because of the higher mortality observed in the obese patients group. COPD patients had a higher hospital LOS, ICU admission, higher percentage of mechanical ventilation, and higher mortality rate when compared to asthma patients. The most prevalent blood type in our patients population was the O positive blood group. Patients with O positive blood type experienced significantly higher hospital LOS when compared to other blood types. In conclusion, two-third of our studied patient population had at least one underlying comorbidity. They were twice as likely to experience a complicated course when compared to patients without underlying medical conditions. There was a 2-fold increase in ICU admission, and requirement of invasive mechanical ventilation. Among those with underlying medical conditions. Furthermore, Mortality rates were twice as high for those with underlying comorbidities compared to those without. There was a high mortality rate observed among those who received mechanical ventilation, almost all patients who received mechanical ventilation passed in our study.

LIMITATIONS

First, our sample size is relatively small, with 271 hospitalized patients included. A selection bias may have been possible, because the data was only derived from Emanate Health hospital and limited in the San Gabriel Valley. Second, the blood types were undetermined for 42.4% of patients, possibly because during the onset of the pandemic, blood typing and cross-matching were not done routinely on all admitted patients. Later on as additional information on COVID-19 and its complications were learned and understood, such as the hypercoagulable state it induces, blood testing was done on all patients. Third, treatment and testing has changed during the course of the study introducing another potential bias. A measurement bias may be considered as different techniques used for SARS-CoV2 RT-PCR testing evolved from the beginning of the pandemic. Testing options later changed as innovation around COVID-19 was quickly promoted, which occurred during the course of the study. Another limitation is that there is limited information on how well controlled the associated comorbidity is. Some underlying medical conditions are undiagnosed or unreported by patients leading to a possible diagnosis bias. Additionally, and most importantly, are the potential cofounders in this study, such as the patient's age, sex, underlying comorbidities and medications that were considered in this study. While strategies were made to reduce the effect of these confounders, including randomization, matching and stratification during data analysis, there is always the possibility that an unmeasured confounder is driving the results. Furthermore, a follow-up study is needed to include patients after discharge to determine the number of reinfection and relapses as well as the long term morbidity and mortality related to COVID-19.

AUTHORS' CONTRIBUTIONS

Hassen Mosa Halil participated in conceptualization of the study design, data collection, data analysis, interpretation, and drafted the manuscript. Ritbano Ahmed Abdo conceived, designed, wrote the study, involved in data collection, and interpretation, and revised draft of the paper. Shamill Eanga Helill and Romedan Delil Kedir participated in conceptualization of the study design and data collection. All authors read and approved the final report of the manuscript.

CONFLICT OF INTEREST

There is no conflict of interest between the authors. This is an independent study done at Emanate Health Queen of the Valley hospital and did not receive third party sponsorship.

AKNOWLEGEMENT

We would like to thank Denise Ronquillo, Nena LaScala, Stella Hua and Linda Waddell for your contributing efforts to this paper.

REFERENCES

1. CDC. Coronavirus disease 2019: cases in U.S. Atlanta, GA: US Department of Health and Human Services, CDC; 2020.
2. Guan W, Liang W, Zhao Y, Liang H, Chen Z, Li Y, et al. Comorbidity and its impact on 1590 patients with Covid-19 in China: A nationwide analysis. Eur Respir J. 2020;55: 2000547.
3. Richardson S, Hirsch JS, Narasimhan M, Crawford JM, McGinn T, Davidson KW, et al. Presenting characteristics, comorbidities, and outcomes among 5700 patients hospitalized with covid-19 in the new york city area. JAMA. 2020; 323:2052–2059.
4. 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. Lancet. 2020;395:1054-1062.
5. Leaf RK, Al-Samkari H, Brenner S, Gupta S, Leaf DE. ABO phenotype and death in critically ill patients with COVID-19. Br J Haematol. 2020;190:e204-e208.
6. Ellinghaus D, Degenhardt F, Bujanda L, Buti M, Albillos A, Invernizzi P. Genomewide association study of severe covid-19 with respiratory failure. N Engl J Med. 2020;383:1522-1534.
7. Cheng Y, Cheng G, Chui CH, Lau FY, Chan PK, Ng M, et al. ABO Blood Group and Susceptibility to Severe Acute Respiratory Syndrome. JAMA. 2005;293:1450-1451.
8. Paudel SS. A meta-analysis of 2019 novel coronavirus patient clinical characteristics and comorbidities. Research Square. 2020;10.
9. Sanyaolu A, Okorie C, Marinkovic A, Patidar R, Younis K, Desai P, et al. Comorbidity and its Impact on Patients with COVID-19. SN Compr Clin Med. 2020;1–8.
10. Arentz M, Yim E, Klaff E, Lokhandwala S, Riedo FX, Chong M, et al. Characteristics and outcomes of 21 critically ill patients with covid-19 in washington state. JAMA. 2020;323:1612-1614.
11. Kanwal A, Agarwala A, Martin LW, Handberg EM, Yang E. COVID-19 and hypertension: what we know and don't know. American College of Cardiology. 2019.
12. Centers for Disease Control and Prevention. (CDCP) Conditions contributing to deaths involving coronavirus disease 2019 (COVID-19), by age group and state, united states. Centers for Disease Control and Prevention. 2021.
13. Chen N, Zhou M, Dong X, Qu L, Gong F, Han Y, et al. Epidemiological and clinical characteristics of 99 cases of 2019 novel coronavirus pneumonia in Wuhan, China: a descriptive study. Lancet. 2020;395(10223):507-513.

14. Onder G, Rezza G, Brusaferro S. Case-fatality rate and characteristics of patients dying in relation to covid-19 in Italy. JAMA. 2020;323:1775-1776.

15. Xie J, Tong Z, Guan X, Du B, Qiu H. Clinical Characteristics of Patients Who Died of Coronavirus Disease 2019 in China.. JAMA Netw Open. 2020;3:e205619.

16. Yang J, Zheng Y, Gou X, Pu K, Chen Z, Guo Q, et al. Prevalence of comorbidities in the novel Wuhan coronavirus (COVID-19) infection: a systematic review and meta-analysis. International Journal of Infectious Disease. 2020;94:91-95.

17. Wu C, Chen X, Cai Y, Xia J, Zhou X, Sha Xu, et al. Risk factors associated with acute respiratory distress syndrome and death in patients with coronavirus disease 2019 pneumonia in wuhan, china. JAMA Intern Med. 2020;180:934-943.

18. Lippi G, Wong J, Henry BM. Hypertension in patients with coronavirus disease 2019 (COVID-19): a pooled analysis. Pol Arch Intern Med. 2020;130:304-309.

19. Guo T, Fan Y, Chen M. Cardiovascular implications of fatal outcomes of patients with coronavirus disease 2019 (COVID-19). JAMA Cardiol. 2020;5:811-818.

20. Chen T, Wu D, Chen H, Yan W, Yang D, Chen G, et al. Clinical characteristics of 113 deceased patients with coronavirus disease 2019: retrospective study. BMJ. 2020;368:m1295.

21. Leung C. Clinical features of deaths in the novel coronavirus epidemic in China. Wiley Online Library.

22. Bloomgarden Z. Diabetes and COVID-19. J Diabetes. 2020;12:347-348.

23. Gupta R, Ghosh A, Singh AK, Misra A. Clinical considerations for patients with diabetes in times of COVID-19 epidemic. Diabetes Metab Syndr. 2020;14:211–212.

24. Muniyappa R, Gubbi S. COVID-19 pandemic, coronaviruses, and diabetes mellitus. Am J Physiol Endocrinol Metab. 2020;318:E736-E741.

25. Corcillo A, Cohen S, Li A, Crane J, Kariyawasam D, Karalliedde J, et al. Diabetic retinopathy is independently associated with increased risk of intubation: A single centre cohort study of patients with diabetes hospitalised with COVID-19. Diabetes Res Clin Pract. 2021;171:108529.

26. Whyte MB, Vas P, Heiss C, Feher MD. The contribution of diabetic microangiopathy to adverse outcomes in COVID-19. Diabetes Res Clin Pract. 2020;164:108217.

27. Cariou B, Hadjadj S, Wargny M, Pichelin M, Al-Salameh A, Allix I, et al. Phenotypic characteristics and prognosis of inpatients with COVID-19 and diabetes: the CORONADO study. Diabetologia. 2020;63:500–1515.

28. Gupta R, Hussain A, Misra A. Diabetes and COVID-19: evidence, current status and unanswered research questions. European Journal of Clinical Nutrition. 2020;74:864–870.

29. Baradaran A, Ebrahimzadeh MH, Baradaran A, Kachooei AR. Prevalence of comorbidities in covid-19 patients: a systematic review and meta-analysis. Arch Bone Jt Surg. 2020;8:247–255.

30. Bornstein SF, Dalan R, Hopkins D, Mingrone G, Boehm B. Endocrine and metabolic link to coronavirus infection. Nat Rev Endocrinol. 2020;16:297-298.

31. Kruglikov IL, Shah M, Scherer PE. Obesity and diabetes as comorbidities for COVID-19: Underlying mechanisms and the role of viral-bacterial interactions. eLife. 2020;9: e61330.

32. Couselo-Seijas M, Almengló C Agra-Bermejo RM, Fernandez AL, Alvarez E, González-Juanatey JR, et al. Higher ACE2 expression levels in epicardial than subcutaneous stromal cells from patients with cardiovascular disease: Diabetes and obesity as possible enhancers. Eur J Clin Invest. 2020;e13463.

33. Moin AS, Al-Qaissi A, Sathyapalan T, Atkin SL, Butler AE. Renin-angiotensin system overactivation in type 2 diabetes: a risk for sars-cov-2 infection?. Diabetes Care. 2020;43:e131-e133.

34. Higham A, Mathioudakis A, Vestbo J, Singh D. COVID-19 and COPD: a narrative review of the basic science and clinical outcomes. Eur Respir Rev. 2020;29:200199.

35. Abbas S, Vijaykumar K, Ramesh N, Blaivas A. Impact of the COVID-19 Pandemic on COPD. Chest American College of Chest Physicians. 2020

36. Kekevian B. COVID-19 With COPD: Fewer Hospitalizations, But Greater Mortality. Pulmonology Advisor. 2019.

37. Green I, Merzon E, Vinker S, Golan-Cohen A, Magen E. COVID-19 Susceptibility in Bronchial Asthma. J Allergy Clin Immunol Pract. 2021;9:684–692.e1.

38. Leung JM, Niikura M, Yang CW, Sin DD. COVID-19 and COPD. Eur Respir J. 2020; 56:2002108.

39. Muñiz-Diaz E, Llopis J, Parra R, Roig I, Ferrer G, Grifols J, et al. Relationship between the ABO blood group and the COVID-19 Susceptibility. Blood Transfus. 2021;19:54-63

40. Harvard Medical School, MGH news and public affairs. Covid-19 and blood type. Harvard Medical School. 2020 https://hms.harvard.edu/news/covid-19-blood-type

41. Latz CA, DeCarlo C, Boitano L, Png CYM, Patell R, Conrad MF, et al. Blood type and outcomes in patients with COVID-19. Ann Hematol. 2020:1–6.