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Logistic regression analysis to predict prognosis in COVID-19 patients at tertiary care center in Rewa, Madhya Pradesh, India

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ABSTRACT

Introduction

SARS-CoV-2 was declared as a global pandemic by World Health Organization (WHO) owing to its high infectivity and pathogenicity that has been quickly entangling the world since its first reported outbreak in China in December, 2019. The main objectives of the present work were to quantify the influence of age, duration of hospitalization, duration of presenting symptoms and comorbidities on the probability of mortality from COVID-19 disease.

Methods

This was a cohort study involving adult in-patients (30th April to 31st December'20) with laboratory-confirmed (RT-PCR) COVID-19 at Sanjay Gandhi and Gandhi Memorial Hospital, Rewa, Madhya Pradesh, India, whose data was retrospectively extracted from hospital records. These files were selected randomly attributing to 25% of the total number of in-patients fulfilling the inclusion and exclusion criteria. Out of the 131 cases, 26 cases were deceased while 105 cases were recovered. A binary logistic regression analysis was employed to quantify various factors responsible for mortality among COVID-19 patients.

Results

The result showed that age & duration of presenting symptoms had a positively significant influence on COVID- 19 mortality. Based on the binary logistic regression model, there is an increased risk of COVID-19 mortality of 1.028 per year of age & 1.213 times per day of presenting symptoms. Further analysis also showed that COVID-19 patients who was hospitalized since 10 days, was approximately 8 times less likely to die as compared to a COVID-19 patient who was hospitalized since 1 day. This is explained by the presence of co-morbidities among older aged patients as reported in previous literature.

Discussion

Among several factors contributing to mortality; in particular, older age and duration of presenting symptoms was associated with higher odds of in-hospital death, while duration of hospitalization with lower odds of in-hospital death. The current study confirmed that increased age was associated with death in patients with COVID-19.

Keywords: COVID-19, Logistic Regression, Prognosis, Mortality, Risk Factors

INTRODUCTION

SARS-CoV-2 was declared as a global pandemic by World Health Organization (WHO) [1] owing to its high infectivity and pathogenicity that has been quickly entangling the world since its first reported outbreak in China in December, 2019. Within the first week of April 2020, more than 1 million individuals globally were infected with COVID-19. These cases come from 209 countries and territories around the world (World Health Organization 2020). In India, the first case of COVID-19 was reported on 30 January, 2020

while in Madhya Pradesh on 20 March 2020. On April 27, 2020, the first COVID-19 case was reported in Rewa, Madhya Pradesh.

The clinical spectrum of SARS-CoV-2 infection includes asymptomatic infection, mild upper respiratory tract illness, and severe viral pneumonia with respiratory failure and even death, with numerous patients being hospitalized with pneumonia in Wuhan.[2-4]

Clinical symptoms like fever, cough, and dyspnoea have been described extensively in published literature. Comparison of characteristics between patients who have died so far and who have recovered, research has revealed that the former were older, more likely to be male, and with comorbidity, such as hypertension, diabetes, cardiovascular disease, or respiratory disease.[5–9] Other risk factors include obesity and smoking.[6,8] Most of these studies are based on Chinese data because China was the initial epicentre of the disease,[5,10] which makes it necessary to assess risk factors in different population groups or settings.

According to the China CDC, first death attributed to this novel coronavirus, named as SARS-CoV-2 (COVID-19 is the associated disease), occurred on January 13, 2020.[11] In India, the first case of death due to COVID-19 was reported on 12 March 2020[12] while in Madhya Pradesh on 26 March 2020.[13] On April 30, 2020, the first COVID-19 death case was reported in SGMH Rewa, Madhya Pradesh.

At the time of formulation of manuscript of this study, there were already 94 reported deaths, and 650 recoveries in SGMH, Rewa.

With this, it might be interesting to determine the magnitude of risk of dying from COVID-19 as associated with various risk factors namely age, and other comorbidities like hypertension, diabetes, cardiovascular disease, chronic respiratory disease and cancer based on cases in Rewa. A final point of paramount importance is that the equation presented here can be used to determine the probability of dying from COVID-19 for a particular patient, given its age, gender and comorbidities associated. This hopefully would be of assistance to health care personnel in improving the care and treatment of COVID-19 cases in the country.

METHOD AND MATERIALS

The main aim of the present work is to compute odds ratio (OR) for death due to COVID-19 considering age, duration of hospitalization, duration of presenting symptoms and co-morbidities as possible risk factors. The dataset included following variables: age, gender, comorbidities and death. Age was described by intervals of decades and the co-morbidities were hypertension, diabetes, cardiovascular disease, chronic respiratory disease and cancer. The outcome variable is dichotomous with states dead and recovered.

Data of total 131 in-patient adults with laboratory-confirmed COVID-19 at SGMH (Rewa) was retrospectively extracted from hospital records. These files were selected randomly attributing to 25% of the total number of in-patients fulfilling the inclusion and exclusion criteria. Confirmed COVID-19 case was defined as a positive result on the reverse-transcriptase polymerase chain-reaction assay of nasopharyngeal/throat swab specimens. Out of the 131 cases, 26 cases were deceased while 105 cases were recovered.

Inclusion Criteria

COVID-19 in-patients recovered or died from this disease, had their case closed and had complete information for explanatory variables (gender, age, comorbidities, and symptoms) in hospital record. The main exclusion criteria were age under 18 years and incomplete information in hospital record.

Epidemiological, demographical, clinical, and outcome data were extracted from hospital record of SGMH using a standardized data collection form. All data were double-checked by the authors. Patient's confidentiality and anonymity was maintained during retrospective data extraction from hospital records.

Place of Study

Department of Community Medicine, Shyam Shah Medical College associated with Sanjay Gandhi and Gandhi Memorial Hospital, Rewa, Madhya Pradesh, India.

Duration of Study

30th April-31st December'20 (08 months).

Outcomes and Predictors

Epidemiological characteristics, clinical signs and symptoms, comorbidities and survival status (recovery or death) were obtained from this dataset.

Statistical Analysis

Descriptive statistics included frequency analysis (%) for all categorical variables. To explore the association of epidemiological, clinical characteristics and the risk for death in 2019-nCoV–infected patients, binary logistic regression models were employed to determining the influence of various risk factors on the probability of a COVID-19 patient to die from the disease. The risk factors of the COVID-19 confirmed cases were treated as the independent variable while the status (deceased/recovered) of the COVID-19 patient is the dependent variable.

Ethical approval for present study was acquired from Institutional Ethical Committee of Shyam Shah Medical College, Rewa and the need of consent from patients was waived off by IEC as data was extracted retrospectively from hospital records after obtaining relevant permissions.

RESULTS AND DISCUSSIONS

Shown in Table 1 are characteristics of COVID-19 survivors and deceased in the hospital setting. There are presently 26 reported deaths and 105 recoveries from COVID-19 cases as extracted from the hospital record during the time of retrieval. The median age of the 131 patients was 48 years [Inter Quartile Range (IQR)-32-60 years], ranging from 19 years to 87 years, and most patients were males.

There were more males (73.1%) in comparison to females (26.9%) who died from COVID-19. Taking recovery into consideration, 73.3% of those who survived were males while only 26.7% were females in our study. Several other studies have also shown that men were hospitalized more frequently than women.[14, 15] Moreover, proportion of men who died from SARS-CoV-2 was more in our study which is in concordance with other studies.[16-18] One possible explanation is that women's immune response to the virus is stronger, and hospital admission and not for death in hospitalized patients. While some of the reports also showed the equivalence of gender in COVID-19 death outcome.[19, 20]

Table 1 Clinical Characteristics of Study COVID-19 Patients by Outcome (Survivors and Non-Survivors) in SGHM, Rewa

Characteristics of COVID-19 Patients		Deceased (%) N=26	Recovered (%) N=105	Total (%) N=131
Age	18 to 28 years old	1 (3.8)	25 (23.8)	26 (19.9)
	29 to 39 years old	5 (19.4)	19 (18.1)	24 (18.3)
	40 to 50 years old	4 (15.4)	20 (19)	24 (18.3)
	51 to 62 years old	8 (30.8)	19 (18.1)	27 (20.6)
	63 to 73 years old	6 (23)	10 (9.5)	16 (12.2)
	74 years old and above	2 (7.6)	12 (11.5)	14 (10.7)
Sex	Male	19 (73.1)	77 (73.3)	96 (73.3)
	Female	07 (26.9)	28 (26.7)	35 (36.7)

Age as Prognostic in COVID-19 Mortality

Table 2 above shows the result of the binary logistics regression model. The model above shows that age is a positive significant determinant of death from COVID-19 based on the B coefficient and the Wald Statistics ($p<0.05$). Furthermore, based on the exponential logistic coefficient [Exp (B)/ Odd's ratio], the risk of dying from COVID-19 increases with age by 1.028 times per year. This is equivalent to around 10.5 times for every 10 years. This roughly means that a 30-year-old COVID-19 patient is approximately 10.5 times more likely to die from the disease compared to a 20-year-old COVID-19 patient.

Our finding is in alignment with various studies[21,22] which also depicted age to be a risk factor for COVID-19 mortality. The main reason for this is the fact that older aged patients also suffer from other illnesses medically termed as comorbidities. Few explanations regarding relationship between old age and co-morbidities have been proposed by researchers, such as decrease in angiotensin-converting enzyme 2 (ACE2) protein expression in older individuals[23] and more contact and developed immune response to other viruses[24,25] and higher prevalence of comorbidities.[26]

Table 2 Binary Logistic Regression Results with Age as Independent Variable (Dependent Variable: 0=Recovered, 1=Deceased)

Variable	B	S.E.	Wald	df	Sig.	Exp (B)
AGE	0.028	0.013	4.645	1	0.031	1.028
Constant	-2.756	0.699	15.532	1	0	0.064

Age as Risk on Comorbidity in COVID-19 Hospitalized Patients

Table 3 above shows the result of the binary logistics regression model. Same as the previous one model shows that age is a positive significant determinant on comorbidity in COVID-19 hospitalized patients based on the B coefficient and the Wald Statistics ($p<0.05$). Furthermore, based on the exponential logistic coefficient [Exp (B)], the risk of morbidity increases with age by 3.19 times per year. This is equivalent to around 32 times for every 10 years. This roughly means that a 50-year-old COVID-19 patient is approximately 32 times more likely to having comorbidity compared to a 40-year-old COVID-19 patient.

Table 3 Binary Logistic Regression Results with Age as Independent Variable (Dependent Variable Comorbidity: 0=Without Comorbidity, 1=With Comorbidity)

Variable	B	S.E.	Wald	df	Sig.	Exp (B)
AGE	1.160	0.433	7.169	1	0.007	3.190
Constant	-1.532	0.561	7.461	1	0.006	0.216

Deficiency of Angiotensin-converting enzyme-2 protein has been associated with various conditions, such as older age, cardiovascular diseases, and diabetes. SARS-CoV-2 could accelerate this deficiency even more, ultimately leading to inflammatory and thrombotic processes.[23] Older patients might also have had more contact with other viruses, causing antibody-dependent enhancement and increasing inflammatory and immunologic responses.[24, 25] At last, higher prevalence of chronic illness has been reported among older population, even those not expressed in the database, such as neurological illness and inflammatory conditions.[26]

In our study, co-morbidities were present in nearly half of patients, with hypertension being the most common co-morbidity, followed by diabetes. In a

previous study conducted[21,22,29,30,31,32,33] cardiovascular 19 patients in China[18]. Furthermore, next to cardiovascular diseases, hypertension was seen to be the most common comorbidity among COVID-19 cases in China[22, 34] along with some cases of diabetes and respiratory diseases. These diseases are noticeably common among older aged patients.

No. of Comorbidities as Prognostic in COVID-19 Mortality

Table 4 above shows the result of the binary logistics regression model. The model above shows that No. of Comorbidities is a positive but non-significant determinant of death from COVID-19 based on the B coefficient and the Wald Statistics. Furthermore, based on the exponential logistic coefficient [Exp (B)], the risk of dying from COVID-19 increases with presence of number of co-morbidities by 1.5 times per co-morbidity.

Table 4 Binary Logistic Regression Results with Comorbidities as Independent Variable (Dependent Variable: 0=Recovered, 1=Deceased)

Variable	B	S.E.	Wald	df	Sig.	Exp (B)
No of Comorbidities	0.416	0.270	2.373	1	0.123	1.515
Constant	-1.725	0.305	31.885	1	0	0.178

Duration of Presenting Symptoms as Prognostic in COVID-19 Mortality

Table 5 above shows the result of the binary logistics regression model. The model above shows that duration of presenting symptoms is a positive significant determinant of death from COVID-19 based on the B coefficient and the Wald Statistics ($p<0.05$). Furthermore, based on the exponential logistic coefficient [Exp (B)], the risk of dying from COVID-19 increases with duration of presenting symptoms by 1.2 times per day. This is equivalent to around 6 times for every 5 days. This roughly means that a COVID-19 patient having symptoms since 5 days; is approximately 6 times more likely to die from the disease compared to a COVID-19 patient having symptoms since 1 day. Shortness of breath and fever were the most frequent symptoms reported in our study. Besides this, duration of presenting complaint was mostly found to be 1 to 5 days. Similar results were observed in previous studies.[18, 19, 29, 32, 33, 35] The median time from illness onset (i.e., before admission) to discharge was 12 days; whereas the median time to death was 11 days in our study.

Table 5 Binary Logistic Regression Results with Duration of Presenting Symptoms as Independent Variable (Dependent Variable: 0=Recovered, 1=Deceased)

Variable	B	S.E.	Wald	df	Sig.	Exp (B)	95% C.I for Exp (B)	
							Lower	Upper
Duration of Presenting Symptoms	0.193	0.069	7.822	1	0.005	1.213	1.059	1.388
Constant	-2.408	0.443	29.496	1	0	0.090		

Duration of Hospitalization as Prognostic in COVID-19 Mortality

Table 6 above binary logistics regression model shows that duration of hospitalization is a significant negative determinant of death in hospitalized COVID-19 cases based on the B coefficient and the Wald Statistics ($p<0.05$). Furthermore, based on the exponential logistic coefficient [Exp (B)], the risk of dying from COVID-19 decreases with duration of hospitalization by 0.82 times per day. This roughly means that a COVID-19 patient who is hospitalized since 10 days is approximately 8 times less likely to die as compared to a COVID-19 patient who is hospitalized since 1 day.

Table 6 Binary Logistic Regression Results with Duration of Hospitalization as Independent Variable (Dependent Variable: 0=Recovered, 1=Deceased)

Variable	B	S.E.	Wald	df	Sig.	Exp (B)	95% C.I for Exp (B)	
							Lower	Upper
Duration of Hospitalization	-0.197	0.067	8.615	1	0.003	0.821	0.720	0.937
Constant	-0.014	0.461	0.001	1	0.975	0.986		

CONCLUSION

This retrospective cohort study identified several prognostic factors for mortality in adults in Rewa who were hospitalized in SGMH with COVID-19. In particular, older age and duration of presenting symptoms was associated with higher odds of in-hospital death, while duration of hospitalization was associated with lower odds of in-hospital death. Previously, older age has been reported as a significant solitary predictor of mortality in COVID-19, the current study confirmed the same .

This type of study on odds of hospitalization and death could affect faster and differentiated care for those at higher risk of mortality, and different prioritization of those with better prognosis. Further study is utmost to better understand the risk factors for mortality by COVID-19 at various tertiary care centres simultaneously.

LIMITATIONS

Interpretation of our findings might be limited by the sample size. In few of the cases, clinical information was inadequate, leading to limited use of some variables in the study and exclusion of incomplete observations, which may have resulted in biased estimation and compromised the representativeness of the samples. Another limitation is that complicated interactions involving many variables may not be correctly interpreted through binary logistic regression. like, cardiovascular disease interacts in many ways with gender, symptoms, age, and other comorbidities, and these interactions may not be linear.

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The findings of the study reveal poor awareness on danger signs during both antenatal and postpartum period. There is probably a need to enhance the health education sessions to all pregnant women irrespective of their demographic characteristics.

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