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Epidemiological, Clinical, and Laboratory Predictors of In-Hospital Mortality Among COVID-19 Patients Admitted in a Tertiary COVID Dedicated Hospital, Northern India: A Retrospective Observational Study

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Abstract

Introduction: COVID-19 pandemic still poses a serious challenge to health system worldwide. This study was planned to determine exposure characteristics, in-hospital mortality, and predictors of in hospital mortality among COVID-19 patients. **Material and methods:** We retrospectively investigated epidemiological, clinical, and laboratory profile of confirmed COVID-19 patients admitted from 25th March to 31st August 2020. COVID-19 patient profiles were collected from Medical Record Section of the hospital. **Results:** In hospital mortality occurred in 159 (11%) cases. Increasing respiratory rate, higher temperature, higher total leukocyte count, and high blood urea levels were found to be independent risk factors for in hospital mortality whereas higher hemoglobin and higher oxygen saturation at the time of hospital admission were found to be protective against in hospital mortality. **Conclusion:** In hospital mortality among COVID-19 patients is almost 1 in 10 in tertiary care hospital. Patients with advancing age (AOR: 1.048; 95% CI: 1.021-1.076), higher respiratory rate (AOR: 1.248; 95% CI: 1.047-1.489), higher temperature (AOR: 1.758; 95% CI: 1.025-3.016), higher leukocyte count (AOR: 1.147; 95% CI: 1.035-1.270), and higher urea levels (AOR: 1.034; 95% CI: 1.005-1.064) at the time of admission are important predictors of COVID-19 in-hospital mortality.

Keywords

COVID-19, hospital mortality, epidemiology

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Introduction

First case of Corona virus disease 2019 (COVID-19) was reported in Wuhan, China in December 2019. Soon the disease spread to most countries of world and was declared Global pandemic by World health Organization on 11th March 2020.[1] In India the first case of COVID-19 was detected on January 30, 2020 in a 20 year old female who had returned to Kerala from Wuhan, China.[2] Mortality rate due to COVID-19 vary across regions but WHO estimates global mortality to be about 3% of cases.[3] COVID-19 pandemic still poses a serious challenge to health system worldwide.

Studies across different countries have found that the clinical presentation and disease outcome among COVID-19 patients to be highly variable.[4-6] To date, most studies from India about COVID-19 epidemiology are reports with small sample size in hospital settings. One study done at Jaipur, Rajasthan which compared 234 mild COVID-19 cases versus 267 negative controls reported about no mortality, greater white blood cells, and lower lymphocyte count among COVID-19 cases.[7]Another study presented case series of 21 initial patients from Safdarjung Hospital,

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New Delhi and reported that over half were asymptomatic and most had travel history outside India.[8]Another study at a tertiary hospital in North India among 144 patients reported that 44 were asymptomatic and comprised of younger population with mortality in 1.4%.[9] Majority of the Indian hospital based studies are among mild or asymptomatic patients or have small sample size to draw conclusions about predictors of poor outcome. Therefore, this study was planned to determine exposure characteristics, in -hospital mortality, and predictors of in hospital mortality among COVID-19 patients admitted between March to August 2020 at a tertiary COVID-19 dedicated hospital.

Material and Methods

This study was done at All India Institute of Medical Sciences, Patna a tertiary care hospital of national importance situated in Bihar state of Northern India. In the beginning of epidemic, the hospital was providing both COVID-19 and Non-COVID-19 health services. Since 13th July 2020 the hospital was made a dedicated tertiary level COVID hospital with 440 general ward beds and 60 bedded Intensive Care Unit (ICU). We retrospectively investigated epidemiological, clinical, and laboratory profile of confirmed COVID-19 patients admitted from 25th March to 31st August 2020. COVID-19 patient profiles were collected from Medical Record Section of the hospital. This study had been approved by the Institutional Ethics Committee (AIIMS/Pat/IEC/2020/525).

All patients of confirmed COVID-19 on the basis of Real Time-Polymerase Chain Reaction or Rapid Antigen Test or True Nucleic Amplification Test (according to Indian Council of Medical Research guideline) admitted in the hospital were included in the study. Exclusion criteria were COVID-19 suspicious patient based on HRCT thorax but negative by methods mentioned above. There was no sample size calculation done for the study as we included all confirmed cases admitted during the period by complete enumeration method.

Age, gender, smoking, alcohol consumption, mode of admission whether referral, contact tracing, or self-admission was collected. History of Diabetes, hypertension, Cardiovascular Disease, Chronic respiratory disease, Cancer, Chronic mental disease, Disability, Chronic Kidney disease with duration was collected. Severity of COVID-19 disease was classified as asymptomatic, mild, moderate, and severe according to Indian Council of Medical Research Guidelines. Blood pressure, temperature, pulse rate, respiratory rate, and oxygen saturation on the day of admission of each participant was collected. Complete blood count, liver function test, kidney function test, electrolytes, and inflammatory markers like CRP, D-dimer, etc. was collected for each participant. All cause in hospital mortality among COVID-19 admitted in the hospital in the period was taken as primary outcome.

Qualitative variables have been presented as counts and percentages. Quantitative variables have been presented as mean; standard deviation or median; interquartile range depending on parametric distribution. Statistical analysis of collected data was done with the help of SPSS 21.0 software. Chi-square test has been applied while seeing association between 2 qualitative variables. Mann-Whitney test and independent *t* test has been applied on quantitative variables. Multivariable logistic regression using 3 models has been assessed to find out independent risk factors for in hospital mortality among COVID-19 patients.

Results

Total 1448 cases of confirmed COVID-19 were admitted in the hospital during of 25th March to 31st August 2020. One thousand forty-nine (72.4%) cases were males (Table 1). Mean age of patient was found to 48.6 years (SD 16.8). Fourteen (1%) had smoking history; alcoholic history was mentioned in 11 (0.8%) of cases. One thousand one hundred thirty-two (78.2%) self-reported for admission followed by 278 (19.2%) who were referred from other hospitals. Four hundred forty-six (30.8%) had history of diabetes, 395 (27.3%) had hypertension; 63 (4.4%) had Cardio vascular diseases excluding hypertension; 13 (0.9%) had history of stroke; 59 (4.1%) had chronic respiratory disease; 6(0.4%) had chronic mental disorder; 53 (3.7%) suffered from chronic kidney disease; and 33 (2.3%) had comorbidity of cancer. One hundred twenty (8.3%) suffered from severe COVID-19 infection according to Indian Council Medical Research criteria. One thousand three hundred fourteen (90.7%) were admitted in general ward for COVID-19. Median duration in hospital was found to be 9 days (IQR: 7-14). Vital signs were assessed in all COVID-19 patients at the time of admission to the hospital. Mean systolic pressure was found to be 128.6 ($\pm$18.8) mm Hg. Mean pulse rate was found to be 90.9 ($\pm$16.5) per minute. Mean respiratory rate was found to be 22.5 ($\pm$5.4) per minute. Mean Oxygen saturation percentage was found to be 95.3 ($\pm$6.7) per minute. Median Temperature was found to be 98°F (IQR: 97-98.5).

Biochemical profile was also assessed among all patients immediately after admission. Mean hemoglobin was found to be 11.8 ($\pm$2) gm/dL as shown in Table 2. Median total leukocyte count was 8.1 (6.0-11.8) $\times 10^6$ cells/μL. Median platelet count was 177 (127-241.7) $\times 10^6$ cells/μL. Median serum bilirubin was found to be 0.9 (0.7-1.2) mg/dL. Serum alanine aminotransferase and aspartate aminotransferase were both higher than their reference range. Median urea level was found to be 29.8 (22.7-45.1) mg/dL. Median creatinine was 0.8 (0.6-1.0) mg/dL. Among inflammatory markers, IL-6 12.7 (4.7-35.2); Lactate Dehydrogenase 731 (536.3-1023.2); ferritin 373.3 (141.7-661.0); and C-reactive Protein 58.8 (8.0-133.9) were higher than normal reference

Table 1. Demographic and Other Baseline Variables of COVID-19 Patients Admitted in the Hospital (n = 1448).

Characteristics	Total	N (%)/mean ± SD
Gender		
Male		1049 (72.4)
Female		399 (27.6)
Age in years ± SD		48.6 ± 16.8
Smoking history	327	14 (4.3)
Alcoholic history	318	11 (3.4)
Admission		
Self-reported		1132 (78.2)
Referral		278 (19.2)
Contact tracing		38 (2.6)
Comorbidity (multiple response)		
Diabetes mellitus	940	446 (47.4)
Hypertension	907	395 (43.5)
Cardio vascular disease	577	63 (10.9)
Stroke	529	13 (2.4)
Chronic respiratory disease	595	59 (9.9)
Chronic mental disease	505	6 (1.1)
Cancer	520	33 (6.3)
Disability	498	02 (0.4)
Chronic kidney disease	536	53 (9.9)
Severity		
Asymptomatic	1290	138 (10.7)
Mild		693 (53.7)
Moderate		339 (26.3)
Severe		120 (9.3)
Place of admission		
Ward		1314 (90.7)
Intensive care unit		134 (9.3)
Duration of stay, days median (IQR)		9 (7-14)
Mortality		
Yes		159 (11.0)
No		1289 (89.0)
Vital signs on admission		
Systolic blood pressure, mm Hg	1349	128.6 (18.8)
Diastolic blood pressure, mm Hg	1350	78.8 (10.9)
Pulse rate, per minute	1380	90.9 (16.5)
Respiratory rate, per minute	1358	22.5 (5.4)
Oxygen saturation, percentage	1381	95.3 (6.7)
Temperature, °F*	1334	98 (97-98.5)

*Median(Inter quartile Range has been presented).

range. In hospital mortality occurred in 159 (11%) cases. Age wise distribution of cases has been summarized in Figure 1. Maximum number of admissions were found in the age-group of 51 to 60 (342). However, maximum number of ICU admissions and deaths occurred in 61 to 70 age group (37 and .38 respectively).

Bivariate analysis was done to assess to risk factors associated with in hospital mortality. Male gender, increasing age, referred patient, diabetic history, hypertensive history, chronic kidney disease history, severe disease had statistically significant association in hospital mortality (as shown in Table 3). Among vital sign and biochemical variables, most had statistically significant association with in hospital mortality (as shown in Table 4). So, multivariable analysis among statistically significant variables was done to look out for independent risk factors and to remove effect of confounders. Three models were tested as shown in Table 5. First model involved only demographic and medical comorbidity history. Increasing age (AOR: 1.046; 95% CI: 1.024-1.068); and chronic kidney disease (AOR: 2.865; 95% CI: 1.094-7.50) were found to be independent predictors of in hospital mortality. This model had a predictive capacity of 10.4% (Nagelkerke $R^2 = .104$). Second model involved both background and vital sign variables. In this model, increasing age (AOR: 1.048; 95% CI: 1.021-1.076), history of chronic kidney disease (AOR: 3.334; 95% CI: 1.015-10.952), and higher respiratory rate (AOR: 1.213; 95% CI: 1.094-1.344) were found to be independent predictors of in hospital mortality. Increasing oxygen saturation (AOR: 0.952; 95% CI: 0.992-0.983) was found to be protective against in hospital mortality. The second model had a predictive capacity of 28.2% (Nagelkerke $R^2 = .282$). In the third model background, vitals and also biochemical variables were included. In this model increasing respiratory rate (AOR: 1.248; 95% CI: 1.047-1.489), higher temperature (AOR: 1.758; 95% CI: 1.025-3.016), higher total leukocyte count (AOR: 1.147; 95% CI: 1.035-1.270), and high blood urea levels (AOR: 1.034; 95% CI: 1.005-1.064) were found to be independent risk factors for in hospital mortality whereas higher hemoglobin (AOR: 0.498; 95% CI: 0.292-0.848) and higher oxygen saturation (AOR: 0.848; 95% CI: 0.770-0.933) at the time of hospital admission to be protective against in hospital mortality. This model had a highest predictive capacity of 59.7% (Nagelkerke $R^2 = .597$)

Discussion

This study revealed about the epidemiology, characteristics and outcomes of the COVID-19 patients who were hospitalized at All Institute of Medical Sciences, Patna during the period of March 22 to August 31st 2020. These were very first cases of COVID-19 in Bihar. This period also coincides COVID-19 first peak in India.[10-12] This was the period when national lockdown was enforced to break the chain of transmission. Initially COVID-19 was only diagnosed by RT-PCR which was also limited to very few ICMR laboratories and was not done at the hospital. Later in the month of April, RT-PCR testing was started in the hospital and upsurge of positive cases was also observed. Total 1448 cases of COVID-19 have been included in the study which can be considered a large sample size since most of study of this duration among Indian hospital settings had a smaller sample size ranging from 21 to 445.[9,13-15]

Table 2. Biochemical Profile of COVID-19 Patients on Admission in the Hospital.

Biochemical variables	N	Normal reference range	Mean ± SD
Complete blood count			
Hemoglobin in, g/dL	1029	11.5-15.5	11.8 ± 2
RBC in cell × 10^6/μL	991	3.9-4.8	4.2 ± 0.8
TLC in cell × 10^6/μL*	1022	3.5-9.5	8.1 (6.0-11.8)
Platelet in cell × 10^6/μL*	1016	125-350	177 (127-241.7)
Liver function test			
Bilirubin in mg/dL*	1000	0.3-1.2	0.9 (0.7-1.2)
Alanine aminotransferase in IL/U*	990	5-35	56.3 (31.7-98.6)
Aspartate aminotransferase in IL/U*	990	8-40	51.1 (33-80.1)
Albumin in gm/dL*	981	3.2-4.8	3.7 (3.4-4.0)
A/G ratio*	980	0.9-2	1.1 (1-1.2)
Kidney function test			
Urea in mg/dL*	1013	7-25	29.8 (22.7-45.1)
Creatinine in mg/dL*	1013	0.5-0.8	0.8 (0.6-1.0)
Electrolyte			
Calcium in mg/dL*	945	8.6-10.3	8.8 (8.4-9.3)
Sodium in mmol/L*	1000	137.0-147.0	135.8 (132.5-138.0)
Potassium in mmol/L*	998	3.5-5.3	4.3 (4-4.7)
Chlorine in mmol/L*	981	96-108	101 (97.9-103.8)
Inflammatory marker			
D-dimer in μg/mL*	652	<1	0.68 (0.41-1.48)
IL-6 in pg/mL*	36	<4.40	12.7 (4.7-35.2)
Lactate dehydrogenase in U/L*	389	120-246	731 (536.3-1023.2)
Ferritin in ng/mL*	664	10-322	373.3 (141.7-661.0)
C-reactive protein in mg/L*	384	<3	58.8 (8.0-133.9)

Abbreviations: IL, interleukin; RBC, red blood count; TLC, total leukocyte count.
*Median (IQR) has been used due to non-parametric distribution.

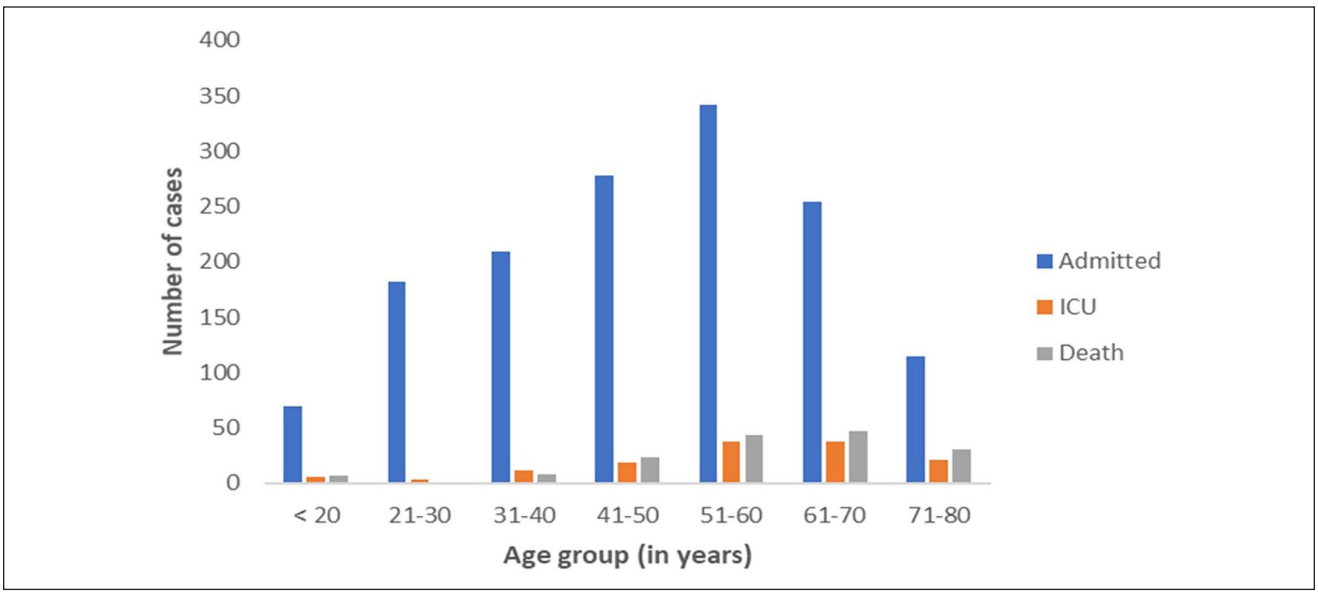

Figure 1. Age wise distribution of admitted COVID-19 patients in the hospital. A total of 1448 cases is shown. A comparison among total patients (blue), ICU admission (orange), and deceased (gray).

Table 3. Association of Sociodemographic and Comorbidity Factors with Mortality in COVID-19 Infection.

Variables	In hospital mortality	In hospital survival	*P* value
Gender			
Female	31 (7.8%)	368 (92.2%)	.016
Male	128 (12.2%)	921 (87.8%)	
Age in years	57.9 ± 15.5	47.44 ± 16.6	<.001
Smoking history			
No	36 (11.5%)	277 (88.5%)	.671
Yes	2 (14.3%)	12 (85.7%)	
Alcoholic history			
No	35 (11.4%)	272 (88.6%)	.373
Yes	2 (18.2%)	9 (81.8%)	
Admission			
As a part of contact tracing	4 (10.5%)	34 (89.5%)	<.001
Referred	64 (23.0%)	214 (77%)	
Reported by self	91 (8.0%)	1041 (92%)	
Diabetes			
No	44 (8.9%)	450 (91.1%)	.012
Yes	63 (14.1%)	383 (85.9%)	
Hypertension			
No	50 (9.8%)	462 (90.2%)	.047
Yes	56 (14.2%)	339 (85.8%)	
Cardiovascular disease			
No	55 (10.7%)	459 (89.3%)	.220
Yes	10 (15.9%)	53 (84.1%)	
Stroke			
No	55 (10.7%)	461 (89.3%)	.641
Yes	2 (15.4%)	11 (84.6%)	
Chronic respiratory disease			
No	56 (10.4%)	480 (89.6%)	.464
Yes	8 (13.6%)	51 (86.4%)	
Chronic mental disease			
No	53 (10.6%)	446 (89.4%)	1.0
Yes	0 (0%)	6 (100%)	
Cancer			
No	49 (10.1%)	438 (89.9%)	.764
Yes	4 (12.1%)	29 (87.9%)	
Disability			
No	53 (10.7%)	443 (89.3%)	.205
Yes	1 (50%)	1 (50%)	
Chronic kidney disease			
No	50 (10.4%)	433 (89.6%)	.008
Yes	12 (22.6%)	41 (77.4%)	
Severity			
Asymptomatic	1 (0.7%)	137 (99.3%)	<.001
Mild	29 (4.2%)	664 (95.8%)	
Moderate	55 (16.2%)	284 (83.8%)	
Severe	65 (54.2%)	55 (45.8%)	

In our study, males constituted almost three-fourth of population (72.4%) which is in line with most hospital-based studies where higher rates of male admissions were observed.[16]The higher rate of male admission might be due to higher rate of smoking among them. Second reason behind this could be males being doing more outdoor activities leading to more exposure as compared to females who are mostly involved in indoor activities in Indian settings. Another reason for male hospitalization could be due to marked sex differences in access to health services. The mean age of our study population was 48.6 (±16.8) years with highest rate of admission in age group of 51 to 60

Table 4. Association of Clinical and Biochemical Variables with Mortality in COVID-19 Infection.

	Inhospital mortality		Inhospital survival		
Variables	N	Mean (SD)	N	Mean (SD)	*P* value
Systolic blood pressure	152	132.1 (26.1)	1197	128.2 (17.6)	<.001
Diastolic blood pressure	152	77.6 (14.5)	1198	79.0 (10.4)	<.001
Respiratory rate	147	26.5 (9.8)	1211	22.0 (4.3)	<.001
Pulse rate	154	95.7 (22.6)	1230	90.3 (15.4)	<.001
Oxygen saturation	152	88.7 (12.9)	1229	96.2 (4.9)	<.001
Temperature*	134	98.1 (97.8-98.5)	1163	98 (97.5-98.5)	.026
Hemoglobin	117	11.1 (2.4)	912	12.0 (1.9)	.001
Red blood count	107	4.0 (0.9)	884	4.3 (0.8)	.004
Total leukocyte count*	116	13.6 (8.9-17.9)	906	7.8 (5.9-10.8)	<.001
Platelet count*	116	162.5 (105.5-250.0)	900	179.0 (128.0-239.5)	.283
Bilirubin*	111	1.0 (0.8-1.5)	889	0.9 (0.7-1.1)	<.001
ALT*	111	55.1 (36.0-55.1)	879	56.7 (31.2-100.4)	.837
AST*	110	68.2 (44.6-94.4)	880	49.9 (32.0-76.6)	<.001
Albumin*	109	3.3 (2.9-3.6)	872	3.8 (3.5-4.1)	<.001
A/G ratio*	109	1.0 (0.8-1.1)	871	1.1 (1.0-1.2)	<.001
Urea*	118	54.2 (39.2-75.6)	895	28.3 (22.0-40.5)	<.001
Creatinine*	115	0.9 (0.6-1.3)	891	0.8 (0.6-0.9)	<.001
Calcium*	115	8.5 (8.5-8.9)	830	8.9 (8.5-9.3)	<.001
Sodium*	118	135.2 (131.3-139.1)	882	135.8 (132.7-138.0)	.810
Potassium*	118	4.5 (4.0-5.0)	880	4.3 (4.0-4.7)	.016
Chloride*	117	99.6 (95.3-103.7)	861	101.0 (98.0-103.8)	.027
D-dimer*	50	2.3 (1.0-8.6)	602	0.6 (0.4-1.3)	<.001
LDH*	45	1156.3 (916.8-1564.6)	344	694.2 (529.1-958.0)	<.001
Ferritin*	43	700.0 (337.3-1171.0)	621	352.0 (134.6-620.0)	<.001
C-reactive protein*	40	170.3 (97.8-236.6)	346	48.1 (7.0-119.3)	<.001

Abbreviations: ALT, alanine aminotransferase; AST, aspartate aminotransferase; LDH, lactate dehydrogenase.
*Median (IQR) has been used.

followed by 41 to 50 and 61 to 70 age groups. This finding of higher rate of admission in middle and advancing age group is in line with previous studies where mean age group ranged from 43.5 to 48.9 years.[14,17]The higher rates of admissions in mid and higher age groups could be due to occurrence of various comorbidities like diabetes and hypertension among them which increased risk of complications in this age group. In our study we included all the cases admitted to the hospital including the ICU patients. Another reason for higher rates of admission in mid and advancing age group in our study could be due to the fact our hospital also provided intensive critical care with facilities of non-invasive and invasive mechanical ventilation which are more often required in advancing age groups. In our study, disease severity of admitted patients ranged from asymptomatic to severe disease with maximum cases of mild followed by moderate category. So, our study reports about all heterogenous groups found in the COVID-19 disease ranging from asymptomatic to severe disease. Median duration of hospital stay in our study was found to be 9 days (IQR: 7-14 days).

In-hospital mortality among admitted COVID-19 patients in our study found in 159 (11%) of cases. One Study which was done in United states of America among 67 000 COVID-19 patients at 592 hospitals during April and May 2020 reported in-hospital mortality to be 20.3% among inpatients.[18]However, an Indian study done at Jaipur among 234 COVID-19 mild cases among young adults reported that all patients recovered from the disease.[7]Another study done in Switzerland among 196 COVID-19 with 25% patients admitted in ICU reported about in-hospital mortality to be about 17%.[19] Another study which assessed in-hospital mortality of patients with COVID-19 across globe which combined findings from 43 studies from 12 countries reported that in-hospital mortality across America, Europe, and Asia to be 22%, 22%, and 12% respectively.[20]Hence, we can conclude that in-hospital mortality among COVID-19 varies widely and this variation probably depends on severity criteria of admission, comorbidities in the patient, presence of ICU facility in hospital, age composition of the region.

In our study, we have tried to identify independent risk factors for in-hospital mortality among COVID-19 patients. Advancing age was identified as independent risk factor in our study with adjusted Odd's ratio of 1.048 in model 2

Table 5. Multivariable Analysis of Various Predictors Variables with in Hospital Mortality of COVID-19 Patients.

	AOR (95% CI)		
Variables	Model 1	Model 2	Model 3
Background			
Gender (male)	1.112 (0.578-2.141)	1.039 (0.474-2.278)	0.534 (0.103-2.776)
Age*	**1.046 (1.024-1.068)**	**1.048 (1.021-1.076)**	1.039 (0.994-1.085)
Diabetes (yes)	1.008 (0.504-2.018)	0.562 (0.237-1.334)	0.364 (0.082-1.623)
Hypertension (yes)	0.694 (0.314-1.537)	0.678 (0.266-1.729)	0.559 (0.123-2.545)
Chronic kidney disease (yes)	**2.865 (1.094-7.500)**	**3.334 (1.015-10.952)**	0.851 (0.031-25.530)
Vitals			
Systolic blood pressure*		0.999 (0.974-1.025)	0.987 (0.944-1.033)
Diastolic blood pressure*		0.979 (0.938-1.023)	1.028 (0.960-1.100)
Respiratory rate*		**1.213 (1.094-1.344)**	**1.248 (1.047-1.489)**
Pulse rate*		1.012 (0.993-1.032)	1.007 (0.968-1.048)
Oxygen saturation*		**0.952 (0.992-0.983)**	**0.848 (0.770-0.933)**
Temperature*		1.316 (0.969-1.786)	**1.758 (1.025-3.016)**
Biochemical			
Hemoglobin*			**0.498 (0.292-0.848)**
Red blood cell count*			1.891 (0.566-6.315)
Total leukocyte count*			**1.147 (1.035-1.270)**
Bilirubin*			1.551 (0.944-2.549)
Aspartate transaminase*			1.002 (0.993-1.012)
Serum albumin*			0.970 (0.396-2.377)
Albumin/globulin ratio*			0.938 (0.040-22.207)
Urea*			**1.034 (1.005-1.064)**
Creatinine*			0.438 (0.175-1.094)
Number	514	428	277
Nagelkerke R^2	0.104	0.282	0.597
Hosmer Lemeshow test	0.303	0.388	0.690

*In increasing order. Significant Odd's Ratio were bolded.

(95% CI: 1.021-1.076). Another study was done in China to compare clinical pattern of disease among younger (<60 years) with respect to old patients (≥60 years) among 788 COVID-19 patients. It was found that presence of comorbidities significantly higher in older patients as compared to younger patients (55.15% vs 21.93%, $P < .001$). Significantly higher rates of severe clinical type (older vs younger: 16.18% vs 5.98%, $P < .001$) was also observed.[21]However, they have not reported about in-hospital mortality among the 2 groups. In another study of retrospective cohort design among 1590 cases in China from 575 hospitals in China reported that increasing age was associated with poor outcome with Hazard ratio of 1.036 (1.021-1.052).[17] In another international, multicenter study done among 1520 patients reported that patients aged 75 years and older had significantly higher mortality (18.4% vs 48.2%, $P < .001$). The reason behind this association can be due to the fact with increasing age number of comorbidities also rise weakening the human physiology.

Comorbidity of chronic kidney disease has been found to independent risk factor for in-patient mortality in our study with adjusted odd's ratio of 3.334 (95% CI: 1.015-10.952). Our findings are consistent with findings from other studies. A prospective cohort study among 701 patients in Wuhan, China reported that serum creatinine (hazard ratio: 2.10, 95% CI: 1.36-3.26) were independent risk factors in-hospital death.[22] Another study calculated estimated Glomerular filtration rate and reported that baseline eGFR was independently associated with mortality (*P*: .005, OR: 0.974, CI: 0.956-0.992).[23] Strong association of Chronic Kidney disease with in-hospital mortality might be due to the fact that ACE2, the cell entry receptor of SAR-CoV-2 is expressed almost 100 times higher in the kidneys compared to lungs.[24]The exact mechanism of this relationship needs to be explored further with studies of larger sample size.

Higher respiratory rate on admission was found to be independent risk factor in our study (AOR, 1.248: 1.047-1.489). This finding is consistent with many other studies done across different geographic locations.[25,26] Lung physiology already affected at time of admission probably might be the reason behind the association.

Higher oxygen saturation at the time of admission has been found to protective against in-hospital mortality (AOR, 0.848: 0.770-0.933). Similar associations have been reported from 1 study which reported decreased oxygen saturation at time of admission was associated with higher mortality (OR, 1.09: 1.06-1.12).[27] This signifies decreased oxygen saturation at the time of admission must be due to already involved lung parenchyma and disease being in advanced stage.

Raised temperature has also been found to be predictor of in-hospital mortality (AOR, 1.758: 1.025-3.016). Similar associations have been reported in previous studies.[28,29]

Abnormally high leukocyte count at the time of admission was found to be independent risk factor for higher mortality in our study (AOR, 1.147: 1.035-1.270). Similar associations have been reported in a couple of studies.[28,30] However, in multivariable analysis the relationship was not found to be statistically significant. Abnormally high rate of total leukocyte count at the time of admission reflects severe inflammatory state which might be the reason for higher mortality.

Our study had few limitations. Firstly, missing data has been present in many of variables. Secondly, our study population is comprised of heterogenous population of mild to severe cases. Variables presented here have been measured at the time of admission. Day since onset of symptoms, socio-economic factors, and treatment provided has not been included in mortality prediction. With time how variables changed has not been ascertained. Inflammatory markers could not be included in multivariable analysis due to lot of missing data. Exact reason for in-hospital mortality has also not been explored in the study. However, our study still holds good value since assesses a large number of variables including comorbidities, vital signs, and biochemical findings in a single study with a quite a large sample size of 1448. Multivariable analysis has been done to find out independent predictors of in-hospital mortality.

Conclusion

In our study, we found that COVID-19 has a high in-hospital mortality of 1 in 10 at a tertiary COVID-19 dedicated hospital. We built a multivariable model based on background, vital signs, and laboratory parameters to predict the in-hospital mortality, which has a high discriminatory power. Our models identify important predictors variables like advancing age, higher respiratory rate, higher temperature, lower oxygen saturation, lower hemoglobin, higher leukocyte count, and higher blood urea levels for in hospital mortality. Based on these findings, early intervention in high-risk patients and rational allocation of medical resources should be done to reduce mortality as much as possible. In home-based care of COVID-19 patients, these factors can be used as first signs of danger. These predictors will also of paramount importance at time of first level of contact with health care provider to predict complications and timely referral.

Author Contributions

All authors had full access to the data, contributed to the study, approved the final version for publication, and take responsibility for its accuracy and integrity.

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