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Clinical and Epidemiological Features of Hospitalized Patients with COVID-19 in Hospitals of Tehran University of Medical Sciences

Vali Baigi[1], Saharnaz Nedjat[2], Masud Yunesian[3], Ali Akbari Sari[4], Mahboobeh Mirzaee[5], Seyed Farshad Allameh[6]*

1. Sina Trauma and Surgery Research Center, Tehran University of Medical Sciences, Tehran, Iran.
2. Department of Epidemiology and Biostatistics, School of Public Health, Knowledge Utilization Research Center, Tehran University of Medical Sciences, Tehran, Iran.
3. Department of Environmental Health Engineering, School of Public Health, Department of Research Methodology and Data Analysis, Institute for Environmental Research, Tehran University of Medical Sciences, Tehran, Iran.
4. Department of Health Management and Economics, School of Public Health, Tehran University of Medical Sciences, Tehran, Iran.
5. Department of Health Information Management, School of Allied Medical Sciences, Vice Chancellor in Treatment Affairs, Tehran University of Medical Sciences, Tehran, Iran.
6. Department of Gastroenterology, Tehran University of Medical Sciences, Tehran, Iran.

***Corresponding author:** Seyed Farshad Allameh; **Email:** allamehfarshad@gmail.com

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Abstract

Introduction: Since the start of COVID-19 pandemic in December 2019, until mid-April 2020 the total number of cases worldwide exceeded two millions and the death toll exceeded 130000 cases.

Objective: The current study conducted to explore the clinical and epidemiological characteristics of COVID-19 patients, fatality of this disease and its mortality risk factors in major hospitals affiliated with Tehran University of Medical Sciences (TUMS).

Methods: The data were collected in four major teaching hospitals affiliated with TUMS for all the patients that were admitted between Feb 19th and Apr 15th 2020 and were diagnosed as COVID-19 using reverse transcription polymerase chain reaction (RT-PCR), clinical diagnosis and/or lung computed tomography (CT) scan. The case fatality rate of the disease was estimated by age, sex, symptoms, comorbidities, and type of diagnosis. Logistic regression model was used to examine the associations between different factors and in-hospital deaths.

Results: By Apr 15th 2020, a total of 4377 patients were admitted with COVID-19 diagnosis in four selected hospitals and 496 (11.3%) of these patients died in hospital. The case fatality rate of this disease was 28.8% in the ≥80-year age group, which was the highest compared to the other age groups. The case fatality rates were 12.5% and 9.8% among men and women, respectively. The results of multiple logistic regression on the outcome of death indicated that age, sex, cough, myalgia, reduced consciousness at arrival and past history of cancer were significantly associated with in-hospital death. Adjusting the effect of other variables, for each 10-year increase in age, the odds of death due to COVID-19 was 1.61 times greater (adjusted OR 1.61, 95% CI: 1.51 to 1.72, p<0.001).

Conclusions: Older age, the male gender, past history of comorbidities (particularly cancer) and reduced consciousness at arrival are among the factors that can significantly increase the odds of in-hospital death in COVID 19 patients. These factors might be helpful in detecting and managing patients with poorer prognosis.

Key words: COVID-19; Epidemiology; Hospital Mortality; Mortality; Odds Ratio

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INTRODUCTION

The COVID-19 pandemic began in December 2019 in Wuhan – China (1). By mid-April 2020 the total number of cases worldwide exceeded two millions and the death toll exceeded 130000 cases (2). Iran is among the countries that were severely affected by this disease and is one of the earliest in the Middle East to report it. The first case was reported in the city of Qom, on Feb 19th 2020 (3, 4). By mid-April over 76388 confirmed cases and 4777 deaths were reported in Iran (2). Tehran has one of the highest infection and mortality rates of the disease in the country. Following the initial detected cases in Tehran, Tehran University of Medical Sciences (TUMS) appointed seven out of its fourteen affiliated hospitals to COVID-19 cases.

To our knowledge, by far, no study has comprehensively described and analyzed the characteristics of the COVID-19 patients admitted

to TUMS hospitals. Thus, the current study was conducted to describe the clinical and epidemiological characteristics of COVID-19 patients, to examine the fatality of the disease and the mortality risk factors of the patients that were admitted to TUMS hospitals.

Methods

Study design and setting

Of the 14 hospitals affiliated with TUMS, seven hospitals including, Imam Khomeini, Shariati, Sina, Amir-Ala'am, Ziaeian, Baharloo and Yas were actively and directly involved in admitting and delivering services to COVID-19 patients. This study used the data of four of these hospitals, namely, Imam Khomeini, Ziaeian, Amir-Ala'am and Shariati. Data from the other three hospitals were not used due to lack of quality and a considerable number of missing data. The study was approved by ethics committee of TUMS (Code number: IR.TUMS.MEDICINE.REC.1399.843). Data analysis and reporting were done anonymously.

Study population

All those affected with COVID-19 based on lab diagnosis reverse transcription polymerase chain reaction (RT-PCR) and/or clinical diagnosis or lung CT scan between Feb 19th and Apr 15th 2020 admitted to the selected hospitals were included in the study.

Data collection

Data were collected using the routine hospital data registration system. The data were routinely entered into this system by senior supervisors at the end of each work-shift. This registration system is a subdivision of the Health Ministry's Medical Care Monitoring Center (MCMC) that routinely registers healthcare data. In this system, in addition to contact information and the patient's address, their national ID number, baseline characteristic (including age and sex), date of disease diagnosis, date of admission, method of diagnosing COVID-19 and clinical data (including disease symptoms at time of arrival and history of comorbidities) were also recorded. Additionally, the patient's final condition (admission, recovery, death) was also documented.

Disease symptoms

Disease symptoms including fever, cough, myalgia, respiratory distress and level of consciousness at arrival were examined for all the patients.

Diagnostic technique

The disease was diagnosed using reverse transcription polymerase chain reaction (RT-PCR) and/or clinical symptoms including fever (≥38 degrees centigrade), dyspnea, chest pain and pressure, respiratory rate <30, PO2<93% and pulmonary infiltration (visible in the chest X-ray).

Comorbidities

The patients' comorbidities were assessed through self-reporting or by their attendants. All the participants were evaluated for the presence or absence of comorbidities, such as, diabetes, cardiovascular diseases (CVD), asthma, respiratory diseases other than asthma, cancer, neurological diseases, blood disorders (Haemolytic anaemias, Coagulation defects), renal disorders, hepatic disorders, acquired immunodeficiency syndrome (AIDS), congenital disorders, and other comorbidities (obesity, transplant, emphysema, Parkinson's and cerebrovascular accident (CVA)). Generally, individuals classified into two groups of patients with no comorbidities and patients with at least one comorbidity.

Statistical analysis

Standard deviation and mean were used for describing the participants' age. Moreover, to show the distribution of cases in different age and sex groups, the symptoms and comorbidities, frequency and percentage were used. The case fatality rate was estimated by sex, age and different symptoms and comorbidities and type of diagnosis. This index was estimated by dividing the number of deaths by the number of patients admitted between Feb 19th and Apr 15th. Moreover, the case fatality rate trend was estimated based on the 3-day moving average.

Given that the final condition (recovery or death) of all the COVID-19 infected cases that had been diagnosed over the last 14 days was unclear, the fatality rate trend analysis was one by omitting the number of admissions over the last 14 days. In other words, here we estimated the case fatality rate index by dividing the number of deaths by the number of patients whose conditions had been determined between Feb 19th and Apr 1st. Furthermore, the daily trend of number of COVID-19 admissions over the period of the study was also illustrated on a graph.

Finally, using the logistic regression model the associations between age, sex, comorbidities, symptoms at arrival and occurrence of in-hospital death were investigated. First, the association between each independent variable and death was examined using univariable logistic regression. In the next step, adjusted ORs were estimated employing logistic regression models. The Hosmer-Lemeshow approach was used to select the final variables for the multiple logistic regression. Level of significance was considered at 0.05. STATA-14 was used to analyze the data.

RESULTS

By Apr 15th 2020 4377 cases were admitted to Imam Khomeini, Ziaeian, Amir-Ala'am and Shariati Hospitals. Of these numbers, 496 (11.3%) cases died. The participants' mean age was 54.5 years (SD=17.4).

Table 1 shows the distribution of affected cases, distribution of expired cases, and case fatality rate of the disease based on various variables. Among different age groups, the 50-59 and 60-69 age groups had the highest frequency among the COVID-19 affected cases (18.9% and 19.2% of the total number of affected cases, respectively). The most common initial symptom in all the patients was cough, which was reported in 2442 (55.8%) cases. Five hundred and fifteen (11.8%) cases were reported to have CVD as well. The case fatality rate in the ≥80 age group was 28.8%, which had the highest fatality compared to the other age groups. In other words, this value indicates that for every 100 cases aged over 80 years old and admitted due to COVID-19, 28.8 people died. The case fatality rate in men was 12.5%; it was 51.3% in cases that had reduced consciousness at arrival. Moreover, the case fatality rate was 32.0% in patients who have cancer.

RT-PCR was performed for 2437 (55.7%) cases; 936 cases came out positive and 693 came out negative. 808 cases' results were unclear by the time this study's results were being analyzed. As shown in Table 2, the case fatality rate in RT-PCR positive cases was 22.8%. It was 4.7% in cases that had not gotten the RT-PCR test done.

Figure 1 demonstrates the daily trend of COVID-19 admissions. Figure 2 illustrates the case fatality rate trend during the period between Feb 19th and Apr 1st. This figure shows what proportion of admitted patients died in hospital (irrespective of when they died). Based on the results, after an initial decline, this index had a constant trend over time.

Table 3 shows the results of univariable logistic regression. Based on these results, for every 10 years increase in age, the odds of death due to

Table 1: Baseline characteristics and case fatality rate of hospitalized Patients with COVID-19

Variable	Case number (N=4377)	Death (N=496)	Case Fatality rate (%)
Age (year)			
≤ 10	3 (0.1)	0 (0.0)	0.0
10 – 19	42 (1.0)	1 (0.2)	2.4
20 – 29	286 (6.5)	6 (1.2)	2.1
30 – 39	668 (15.3)	18 (3.6)	2.7
40 – 49	773 (17.7)	38 (7.7)	4.9
50 – 59	828 (18.9)	83 (16.7)	10.0
60 – 69	840 (19.2)	116 (23.4)	13.8
70 – 79	555 (12.7)	124 (25.0)	22.3
≥ 80	382 (8.7)	110 (22.2)	28.8
Sex			
Male	2473 (56.5)	187 (37.7)	12.5
Female	1904 (43.5)	309 (62.3)	9.8
Clinical symptoms in admission			
Fever	1874 (42.8)	196 (39.5)	10.5
Cough	2442 (55.8)	198 (39.9)	8.1
Myalgia	1444 (33.0)	100 (20.2)	6.9
Respiratory distress	1928 (44.0)	238 (48.0)	12.3
Loss of consciousness	115 (2.6)	59 (11.9)	51.3
Self-reported Comorbidities			
Cancer	128 (2.9)	41 (8.3)	32.0
Diabetes	506 (11.6)	83 (16.7)	16.4
Cardiovascular disease	515 (11.8)	92 (18.5)	17.9
Chronic renal disease	95 (2.2)	23 (4.6)	24.2
Chronic liver disease	35 (0.8)	9 (1.8)	25.7
Asthma	78 (1.8)	6 (1.2)	7.7
Chronic lung diseases	67 (1.5)	11 (2.2)	16.4
Chronic blood diseases	52 (1.2)	13 (2.6)	25.0
HIV infection	11 (0.3)	0 (0.0)	0.0
Chronic neurological disorders	25 (0.6)	8 (1.6)	32.0
Congenital disorder	24 (0.5)	1 (0.2)	4.2
Other diseases[a]	298 (6.8)	41 (8.3)	13.8
At least one comorbidity[b]	1297 (29.6)	225 (45.4)	17.3

a: obesity, Parkinson, cerebrovascular accident, organ transplantation.

b: Anyone suffering from at least one of the mentioned diseases

Table 2: Case fatality rate of hospitalized Patients with COVID-19 by diagnostic method

Real time RT-PCR	Case number (N=4377)	Death (N=496)	Case Fatality rate (%)
Yes			
Negative	693 (15.8)	110 (22.2)	15.9
Positive	936 (21.4)	213 (42.9)	22.8
Following (not reported)	808 (18.5)	82 (16.5)	10.1
No	1940 (44.3)	91 (18.3)	4.7

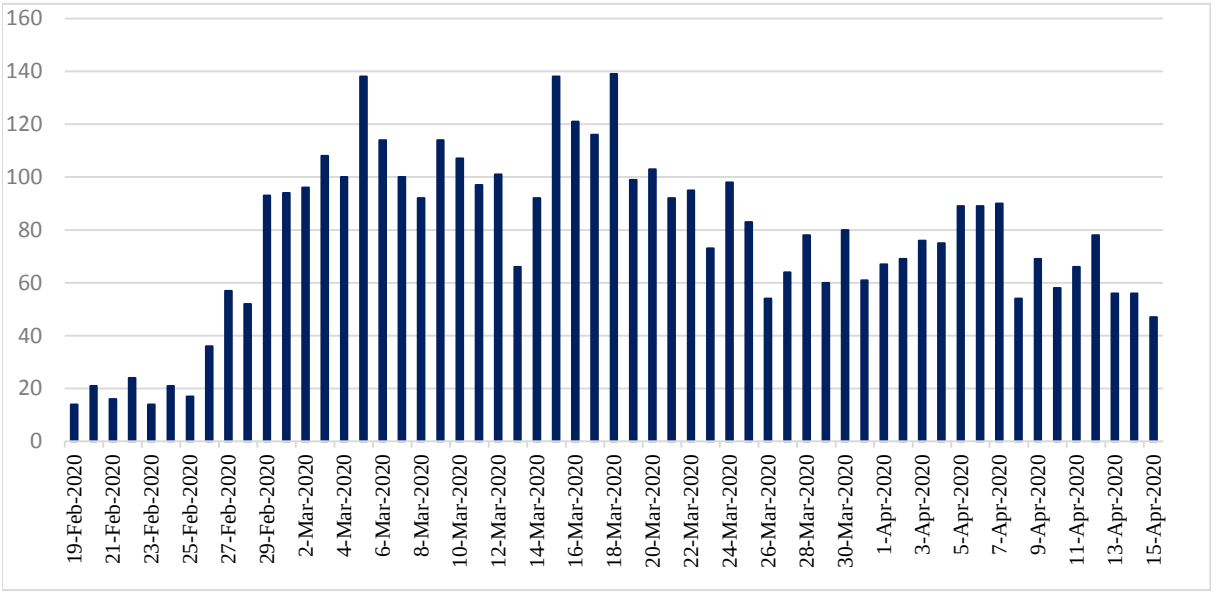

Figure 1: Daily new hospitalized cases of COVID-19 from February 19 to April 20, 2020

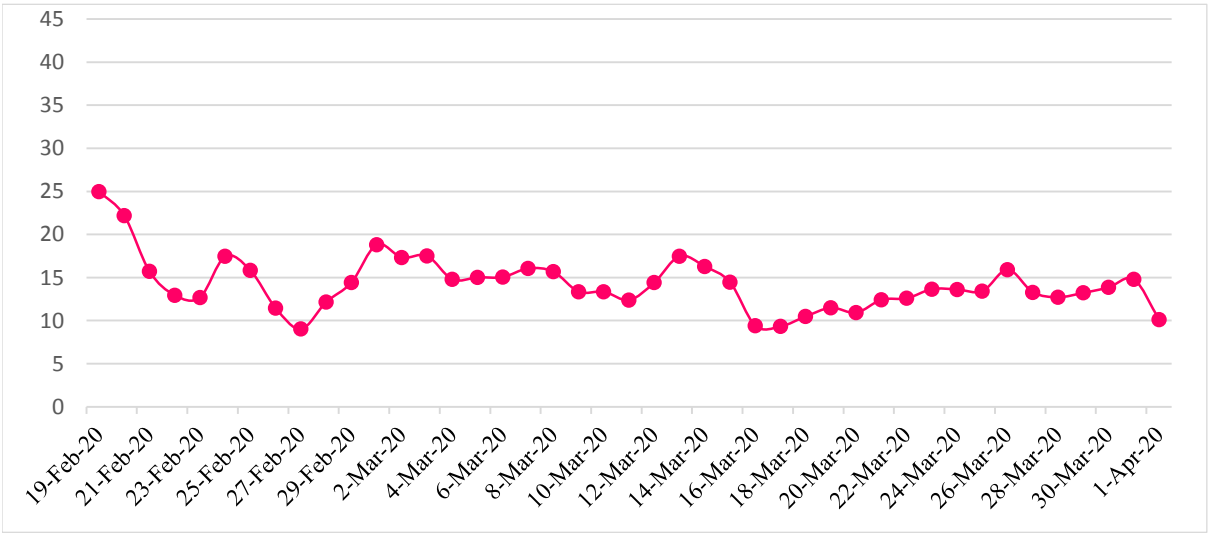

Figure 2: Daily case fatality rate (%), rolling 3-day average

COVID-19 increases by 1.66 times (p<0.001). The odds of death in cases with reduced consciousness at arrival was 9.22 times the odds of death in those who did not have reduced consciousness at arrival (p<0.001).

Results of multiple logistic regression indicated that age, sex, cough, myalgia, and reduced consciousness at arrival and a past h/o cancer had a statistically significant association with in-hospital death. According to these results, regardless of the effect of the other variables, the odds of death in men was 1.32 times that in women (p=0.006). For every 10 years increase in age, the odds of death due to COVID-19 increased by 1.61 times (95% CI: 1.51 to 1.72, p<0.001). Moreover, the odds of death in individuals who have cancer

Table 3: Univariable logistic regression models of in-hospital mortality, OR (95% CI for OR). N=4377

Variable	Unadjusted OR	95% CI for OR
Age	**1.66**	**(1.56 to 1.77)[a]**
Gender		
Female	Ref	
Male	**1.31**	**(1.08 to 1.59)**
Clinical symptoms in admission		
Fever	0.86	(0.71 to 1.04)
Cough	**0.48**	**(0.40 to 0.59)**
Myalgia	**0.48**	**(0.37 to 0.60)**
Respiratory distress	1.19	(0.99 to 1.44)
Loss of consciousness	**9.22**	**(6.31 to 13.46)**
Self-reported Comorbidities		
Cancer	**3.93**	**(2.68 to 5.77)**
Diabetes	**1.64**	**(1.27 to 2.12)**
Cardiovascular disease	**1.86**	**(1.45 to 2.38)**
Chronic renal disease	**2.57**	**(1.59 to 4.15)**
Chronic liver disease	**2.74**	**(1.27 to 5.88)**
Asthma	0.65	(0.28 to 1.50)
Chronic lung diseases	1.55	(0.81 to 2.98)
Chronic blood diseases	**2.65**	**(1.41 to 5.00)**
Chronic neurological disorders	**3.73**	**(1.59 to 8.68)**
Congenital disorder	0.34	(0.05 to 2.51)
Other Diseases	1.27	(0.90 to 1.79)

a: Bold indicates p<0.05

Table 4: Multiple logistic regression models of in-hospital mortality, OR (95% CI for OR). N=4377

Variable	Adjusted OR	95% CI for OR
Age	**1.61**	**(1.51 to 1.72)[a]**
Gender		
Female	Ref	
Male	**1.32**	**(1.08 to 1.64)**
Clinical symptoms in admission		
Cough	**0.65**	**(0.53 to 0.79)**
Myalgia	**0.69**	**(0.54 to 0.88)**
Loss of consciousness	**6.50**	**(4.35 to 9.83)**
Self-reported Comorbidities		
Cancer	**3.70**	**(2.44 to 5.60)**

a: Bold indicates p<0.05

increased by 3.70 times compared to those with no past history of cancer (p<0.001) (Table 4).

Discussion

Men comprised the majority of the COVID-19 cases admitted in four selected hospitals during the first two months of the epidemic. The majority of the admitted cases were from the 50-59 and 60-69 age groups. 11.3% of all the admitted individuals died during this period. The highest case fatality rate was observed in the ≥80 age group. In addition to age and sex, cough, myalgia and reduced level of consciousness at arrival and past h/o cancer (that were reported by the patients or their attendants) had a statistically significant association with in-hospital death.

Different studies have reported varying case fatality rates for this disease (5-7). By Apr 15th, these rates were estimated at 13.1%, 4.1% and 2.8% in Italy, China and Germany, respectively (6, 8). The value estimated in our study is higher than those of China and Italy. One of the reasons behind this difference is the population used as the denominator of this index. In other words, depending on whether the denominator used is the number of severe, mild, or the total number of infected cases, the value obtained can be affected by overestimation, underestimation or be accurately estimated (7, 9). In the current study, the denominator of this index was the number of cases admitted with COVID-19. If the admission of affected individuals is considered as an indicator of the severe form of the disease, this point can justify the higher value of this index in the current study, and must be taken into account in its interpretation. In the Chinese and German studies, the denominator was the total number of confirmed COVID-19 cases (severe and mild cases). Furthermore, the difference in age combinations between our study and China is another important difference in case fatality rate of the two studies; the number of ≥60-year-olds affected in our study

was higher than its Chinese counterpart (10). The case fatality rate in Italy was higher than that of our admitted cases. This may be justified by the older age of the affected population in Italy compared to the population under study in Iran (11).

Earlier studies have also reported increasing age (old age) as an important prognostic factor for in-hospital deaths in COVID-19 (12-15). It has also been observed that the infection and mortality rates differ between men and women (15, 16). Consistent with our findings, the results of a meta-analysis indicated that the frequency of severe cases and their related deaths were higher in men than in women (17).

Based on evidence, the presence of comorbidities raises the odds of COVID-19's progression towards its severe form and death (18-21). A review of evidence indicates that the following comorbidities are associated with a poorer prognosis of COVID-19; cancer, CVD, diabetes, pulmonary diseases, hypertension, and renal disorders (13, 20-22). In the same vein, Cummings et al observed that cardiovascular and pulmonary diseases statistically and significantly raised the odds of death due to COVID-19 in the 257 affected patients admitted to New York's hospitals. Furthermore, diabetes and hypertension were not statistically & significantly associated with COVID-19 related deaths (12).

Liang at al studied 1590 COVID-19 patients and observed that old age, past h/o cancer, reduced level of consciousness and difficulty breathing were among the most important prognostic factors of the severe form of this disease and its related deaths (23).

Limitations

COVID-19 patients' data have been registered in the routine hospital data registration system. Thus, some of the important variables may not have been registered in this system. Given that at the time of data analysis the final condition of all the patients were not clear, the fatality rate of the disease may have been underestimated. Nevertheless, we did try to prevent this problem by omitting the cases of the last 14 days in the daily trend analysis of the fatality rate. Furthermore, due to the relatively fewer number of affected individuals in the ≤30 age group, the fatality rate of this group must be interpreted with caution. The population under study comprised those admitted in hospitals. Thus, it cannot be representative of the entire population affected with COVID-19. Therefore, generalization of these results to the aforementioned population must be done with caution.

Conclusions

As the first comprehensive descriptive – analytic study by TUMS on its affiliated hospitals, this report offers valuable information on COVID-19 patients. Based on the results, age, the male gender, myalgia and reduced consciousness at arrival and a past history of cancer were significantly associated with in-hospital death. Older age, the male gender, past history of cancer and reduced consciousness at arrival raise the odds of COVID-19's progression towards death significantly & statistically. Nevertheless, it must be noted that approximately 70% of the admitted cases had no past h/o comorbidities and approximately 9% of these died. Thus, regardless of comorbidities, all COVID-19 patients should receive special care and attention.

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None.

Authors' contribution

VB and SN made substantial contributions to the study conception and design, the acquisition, analysis and interpretation of data, drafting the manuscript, and revising the manuscript critically for important intellectual content. MM, AAS and SFA contributed to the study design, acquisition and interpretation of data, and revised the manuscript critically. MY participated in statistical analysis, interpretation of data and revising the manuscript critically for important intellectual content. All authors agreed on the final manuscript prior to submission. All authors agreed to be accountable for all aspects of this work.

Conflict of interest

Seyed Farshad Allameh is Vice- chancellor in treatment affairs at Tehran University of Medical Sciences. The other authors declare that there is no conflict of interest.

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