



The Impact of COVID-19 on Trauma Emergency Patients in Southeastern Iran

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ABSTRACT

Objective: With the COVID-19 outbreak in countries around the world, the countries' healthcare systems underwent an unprecedented shock. This study aimed to examine the resilience of the medical service delivery system in providing emergency services during the Covid-19 pandemic.

Methods: This study was conducted in a reference hospital in Kerman that provided emergency services to trauma patients. It compared service delivery before and after COVID-19, as well as during the COVID-19 peak and non-peak periods. The compared variables were the number of trauma patients admitted to the hospital and the ICU, the number of patients who died in the hospital due to trauma, and the length of stay in the hospital and the ICU.

Results: The pre- and post-COVID-19 comparisons showed no significant difference in the number of daily hospital admissions, ICU admissions, and patient deaths. The median length of stay in the ICU was significantly reduced by almost 2 days during the COVID-19 outbreak. However, the length of stay at the hospital was almost the same. Furthermore, a comparison of the COVID-19 peaks and non-peak periods indicated no statistically significant difference in the number of admissions in the ICU, hospital and ICU length of stay, and trauma-induced mortality.

Conclusion: Despite the substantial workload imposed by COVID-19 on hospitals, especially during the peak periods of the disease, the provision of medical services to emergency trauma patients did not drop significantly, and the quality of services provided to patients was within the acceptable range.

Keywords: Trauma, COVID-19, Health service, Iran.

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Introduction

With the spread of the coronavirus worldwide, different countries faced challenges never experienced before. These problems especially affected the healthcare system in an unprecedented way. Thus, the COVID-19 pandemic was undoubtedly the largest healthcare challenge of the 21st century [1]. In Iran, the same as other countries, COVID-19 rapidly became the number one health problem [2]. Despite the implementation of various policies to prevent the spread of the disease, as of November 18, 2021, more than 6 million patients and more than 128.5 thousand deaths from this disease were recorded [3]. Extensive study showed that the COVID-19 pandemic has also affected healthcare services provided to other patients [4]. Thus, at the peak of the disease, the admission of new patients and the shortage of medical staff made it difficult to admit patients or provide care for them [5, 6]. In addition, due to the widespread of the disease and its high percentage of deaths and hospitalizations, all the capacity of the country's hospitals, medical staff, and even the policymakers' health decisions were more focused on COVID-19 patients, leading to more deaths during the epidemic [7].

Trauma is one of the leading causes of death in Iran, with a large proportion of fatalities occurring among young individuals [8, 9]. Traffic accidents and both intentional and unintentional injuries have always accounted for a high mortality rate in Iran [10, 11]. Traffic accidents are the most important cause, for which trauma patients visit the hospital [12]. Traffic accidents in Iran have been and still are one of the medical challenges [13]. According to a report by WHO in 2018, the annual death rate due to road accidents in Iran was 20.5 per 100,000 people, which was higher than the global average [12]. Studies reported several causes for the higher number of accidents in Iran compared to other countries. The most important of which are unsafe roads and vehicles, as well as human factors, such as drivers' lower concentration and alertness [14].

During the COVID-19 epidemic, especially at peak times, one of the government's policies was to implement the social distancing law to prevent the spread of the disease. This regulation imposed bans on entering and exiting cities of the country to prevent the rapid transmission of the virus to other cities [15]. On the other hand, this policy would make individuals travel less, which could potentially reduce the number of accidents and visits of accident victims [16]. Although COVID-19 temporarily reduced car accidents, it increased some other injuries. For instance, domestic violence and suicide increased during the pandemic due to stress and anxiety caused by economic uncertainty, social isolation, the illness of the individual or their family members, or the loss of their relatives [17]. According to studies, there was a significant increase in incidents of sexual partner

violence and child abuse during the COVID-19 pandemic [18, 19].

Understanding the care provided to trauma patients is essential for future health system planning and pandemic preparedness. Studies in different countries reported that the total number of outpatient visits at national levels decreased by 9 to 40% during the epidemic [20]. In addition, maternal health services were disrupted in almost half of the countries, decreasing from 5% to 33% [21]. During the peak times of the COVID-19 waves, many beds from other departments of the hospital were occupied by COVID-19 patients. Hence, the provision of medical services to other patients, especially during the COVID-19 peak waves (when the number of COVID-19 referrals, and consequently, the number of deaths due to the disease increased) might not be the same as before the peak times [22]. In this way, this study aimed to compare the number of admissions of trauma patients and the length of stay in the ICU before and after the COVID-19 pandemic. This comparison can reveal the effects of the pandemic on the medical services provided to trauma patients. This study also compared the number of visits and the length of stay of trauma patients in the hospital and the ICU during the COVID-19 peaks and non-peak times. This comparison could indicate effective planning for patient treatment management and show the impact of COVID-19 on the length of stay of trauma patients.

Materials and Methods

This study used cross-sectional data in Kerman, which has a population of approximately 800,000 people. Trauma data were extracted and analyzed from the electronic files of patients admitted to Shahid Bahonar Hospital (Kerman, Iran) from 2018 to 2021. Shahid Bahonar Hospital in Kerman is a trauma referral center in southeastern Iran that admits and treats trauma victims.

The patients who visited the hospital as outpatients or were hospitalized for less than 6 hours were excluded from the study. Moreover, patients with incomplete medical records were excluded from the study. This number was relatively small, around 10 patients. Finally, the data of 13,720 patients, who visited the hospital from May 23, 2018, to November 18, 2021, were analyzed.

This study evaluated the patient's condition before and during the COVID-19 pandemic, as well as during the COVID-19 peak and non-peak times.

To investigate the difference in service delivery before and during the COVID-19 pandemic, the following variables were compared in these two timeframes: (1) The length of trauma-related hospital and ICU stays and (2) The number of hospital and ICU admissions and patient deaths. For the first analysis, sex, age, nationality, marital status, and the pandemic time (before and during the pandemic

[B.D.P]) were used as independent variables, and the length of hospital and ICU stay in days was used as the response variables. The variable (B.D.P) was dichotomous and was defined as pre-Covid-19 and post-Covid-19 time. Previous study and the present data indicated that coronavirus has been circulating in Kerman since late February 2019 [23]. Thus, the period from May 23, 2018, to February 19, 2020, was considered the pre COVID-19 period, and the period from February 20, 2020, to November 18, 2021(the end of the study) was considered as the time of the COVID-19 outbreak (during the pandemic). The number of days before and during the outbreak was considered the same, and it was equal to 638 days. In this analysis, each data point was reviewed and analyzed separately. Since the patient's length of stay did not follow the normal distribution, quantile regression was used to compare the length of stay before and during the COVID-19 pandemic, as well as the factors affecting them. Besides, to compare the number of patients admitted to the hospital and ICU, and their deaths, the average age of the patients on each day, the percentage of patients with Iranian nationality on each day, and the percentage of married patients on each day were considered as independent variables, and the number of patients referring to the hospital each day were considered as the response variable. In this case, the data were aggregated and entered into the analysis. The negative binomial regression method was used to analyze the number of patients admitted to the hospital. Zero-inflated negative binomial regression was also used to analyze the patients admitted to the ICU and the deaths of patients in the hospital.

The second objective of the present study was to compare the length of hospital and ICU stay, the number of patients admitted to the ICU, and their deaths during the COVID-19 peak and non-peak times. The timeframe of this group of analyses was during the COVID-19 pandemic. The response variable was the length of hospital and ICU stay, and the independent variable was sex, age, nationality, marital status, and peak time. As previously stated, since patients' length of stay did not follow a normal distribution, the quantile regression was used. In the

second analysis, as the number of days investigated in peak and non-peak times was not the same, the ratio of the number of patients admitted to the ICU to the total number of patients and the number of patients who died to the total number of patients admitted in peak and non-peak times were compared using two proportion Z-test.

The peak time of the disease wave occurs when the number of new COVID-19 cases begins to decrease rather than continue on a dramatic increase trend. In other words, the peak refers to the highest number of COVID-19 cases in a country, state, or city, after which the infection rate decreases [23]. In this study, the peak times were determined by examining the number of positive case trends. To determine the COVID-19 peak points, the number of daily positive PCR cases for Kerman was received from the Ministry of Health, Treatment and Medical Education. Since the number of daily positive results fluctuated a lot, Friedman's super smoother was used to smooth the data [24]. Accordingly, the COVID-19 peak times were determined. Since the peak workload of hospitals continued from two weeks before the COVID-19 peak to two weeks afterward, this period was chosen as the COVID-19 peak period for analysis. Thus, the COVID-19 peak, as a dichotomous qualitative variable, was entered into the analysis as 1- the COVID-19 peak period and 2- the non-peak period. The R software was used to smooth the data. Other statistical analyses were performed using Stata-17 software. P -values<0.05 were considered statistically significant.

Results

In general, 6876 patients (50.1%) were admitted to the hospital due to trauma prior to the pandemic and 6844 patients (49.90%) during the pandemic. Moreover, 1157 patients (49.57%) were admitted to the ICU before and 1177 patients (50.43%) during the pandemic (Figure 1).

As previously indicated, the number of days before and during the COVID pandemic was considered the same and equal to 638 days. The average number of patient admissions before the COVID-19 pandemic

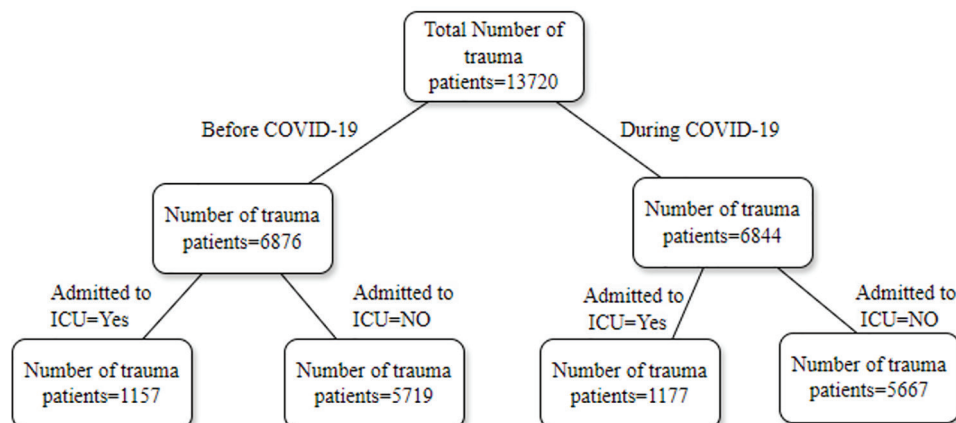


Fig. 1. Comparison of ICU and Trauma Patient Admissions: Pre-Pandemic vs. Pandemic

was 10.78 ± 4.35 per days, and during the pandemic it was 10.73 ± 4.33 per days. The average number of patient admissions to the ICU before COVID-19 was 1.81 ± 1.45 per days, but during the COVID-19 pandemic it was 1.84 ± 1.51 per days. Moreover, the median and IQR age of the patients admitted to the hospital was 22.00 ± 27.00 , whereas that of the patients admitted to the ICU was 30.0 ± 25.0 . The majority of patients admitted to the hospital and ICU were Iranian and single (Table 1). The results showed no significant difference in the number of hospital and ICU admissions during the COVID-19 pandemic compared to the pre-COVID-19 pandemic (Table 2).

The median and IQR for the length of hospital stay before and during the COVID-19 outbreak were 3.00 ± 3.75 days and 2.00 ± 4.00 days, respectively. The median and IQR for the length of ICU stay before and during the COVID-19 outbreak were 8.0 ± 12.0 and 6.0 ± 10.0 days, respectively. The majority of patients admitted to the ICU were Iranian and married (Table 1). The study found no significant difference in the median length of hospital stay before and during the COVID-19 outbreak ($p=1.00$). However,

the median length of ICU stay during the pandemic was significantly reduced by 2.26 days compared to the pre-COVID-19 period ($p<0.001$) (Table 2).

The mean deaths before and during the COVID-19 pandemic were 0.034 ± 0.18 and 0.028 ± 0.16 , respectively. The median and IQR age of the deceased patients was 36.0 ± 39.0 . As before, most of the deceased patients were of Iranian nationality, men, and married (Table 1). Although the number of deaths during the COVID-19 pandemic decreased compared to the pre-COVID-19 time, the difference was not statistically significant (Table 2).

This study found that the number of hospital admissions due to trauma was evenly distributed throughout COVID-19. Figure 2 shows the number of positive PCR cases in Kerman during the COVID-19 peak times, and the number of patients admitted due to trauma:

The total number of patients who visited the hospital during the COVID-19 pandemic was 6844. During the peak periods of the disease, 929 patients (13.6%) were admitted to the hospital, of which 164 patients (17.65%) were admitted to the ICU, and 21 patients (2.26%) died.

Table 1. The number of hospital and ICU admissions, length of hospital and ICU stays, and trauma-related mortality in the pre- and post-COVID-19 period

Variables		Hospital	ICU	Death
		Number (%); Median±IQR	Number (%); Median±IQR	Number (%); Median±IQR
B.D.P*	Before	6876 (50.10); 3±3.75	1157 (49.6); 8±12	234 (54.9)
	During	6844 (49.90); 2±4	1177 (50.4); 6±10	192 (45.1)
Age		27±22	30±25	36±39
Nationality	Iranian	12680 (92.40); 2±4	2138 (91.6); 7±12	393 (92.3)
	Afghan	1040 (7.60); 2±4	196 (8.40); 7±11	33 (7.3)
Sex	Male	11235 (81.9); 2±4	1863 (79.8); 7±12	345 (81.0)
	Female	2485 (18.10); 2±4	471 (20.2); 7±10	81(19.0)
Marital status	Single	7187 (52.4); 2±3	1089 (46.7); 7±10	171 (40.1)
	Marriage	6532 (47.6); 2±5	1245 (53.3); 8±12	255 (59.9)

*Before and during pandemic

Table 2. Comparing the number of hospital and ICU admissions, length of hospital and ICU stays, and trauma-related mortality in the pre- and post-COVID-19 period

Action	Variables	Regression coefficient/ [RR] (CI)*	P value
Hospital	Number of referrals	Before	Ref
		During	[0.99 (0.95, 1.04)]
	Duration of hospitalization	Before	Ref
		During	0.0 (-0.11, 0.11)
ICU	Number of referrals	Before	1
		During	[1.01 (0.93, 1.10)]
	Duration of hospitalization	Before	Ref
		During	-2.26 (-3.02, -1.50)
Death	Number of deaths	Before	1
		During	[0.88 (0.70, 1.10)]

*Regression coefficients are median that adjusted by age, sex, marital status and nationality; RR adjusted by mean age, marital status (marriage percent), and nationality (Iranian percent); CI: 95% Confidence interval

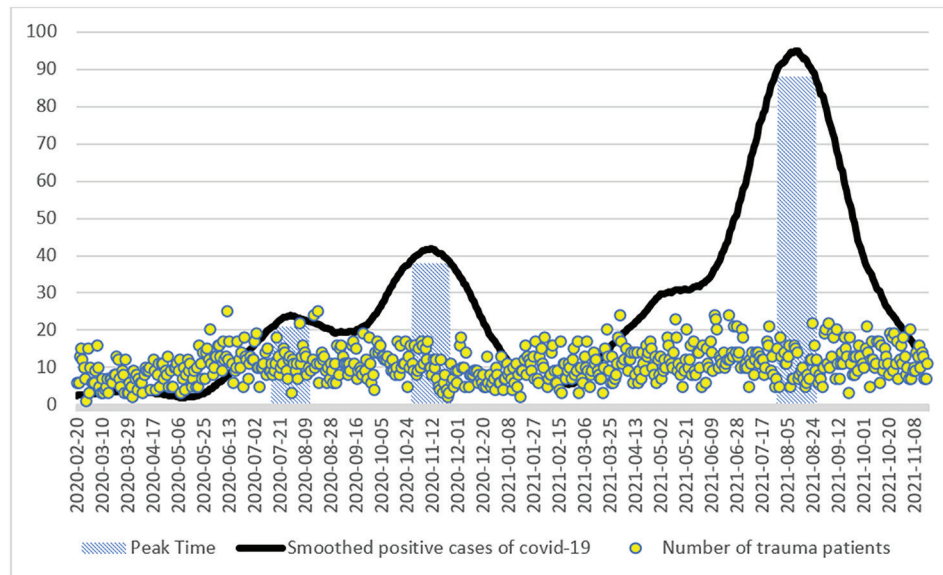


Fig. 2. The number of hospital admissions due to trauma during COVID-19 peak and non-peak times

Table 3. Comparing the average length of hospital and ICU stays due to trauma during the COVID-19 peak and non-peak times

Variables		Hospital	ICU
		Number (%); Median±IQR	Number (%); Median±IQR
Pandemic	Peak	929 (13.6); 2±4	164 (13.9); 7±12.75
	Not-peak	5915 (86.4); 2±4	1013 (86.1); 6±10
Age		26±22	30±25
Nationality	Iranian	6298 (92.0); 2±4	1064 (90.4); 6±10
	Afghan	546 (8.0); 2±4	113 (9.6); 6±12
Gender	Male	5669 (82.8); 2±4	950 (80.7); 6±10
	Female	1175 (17.2); 2±4	227 (19.3); 6±10
Marital status	Single	3802 (55.6); 2±3	588 (50.0); 6±9
	Marriage	3042 (44.4); 3±4	589 (50.0); 7±12

The number of patients admitted to the hospital during the COVID-19 non-peak time was 5915, of which 1013 patients (17.13%) were admitted to the ICU, and 171 patients (2.89%) died. A comparison of the two ratios showed no significant difference between ICU admissions and the death of patients during the COVID-19 peak and non-peak times.

The median and IQR for hospital admissions during COVID-19 peak and non-peak times were 2.0±4.0 days. The median and IQR for ICU admissions was 7.0±12.75 days during peak times and 6.0±10.0 days during non-peak times. Table 3 shows no significant difference in the median length of hospital and ICU stays during the COVID-19 peak and non-peak times ($p=1.00$).

Discussion

The present study investigated the effect of the COVID-19 pandemic on the provision of services to emergency trauma patients in Kerman. For this purpose, the average length of hospital and ICU stays, number of hospital and ICU admissions, and trauma-related mortality were compared before and during the COVID-19 pandemic. Moreover, the same

variables were compared during the COVID-19 peak and non-peak times. The findings indicated that the length of stay in the ICU decreased significantly during the COVID-19 pandemic compared to the pre-COVID-19 period. However, there was no significant difference in the number of hospital and ICU admissions, length of hospital and ICU stays, and trauma-related mortality. In addition, there was no significant difference in the number of hospital and ICU admissions, length of hospital and ICU stays, and trauma-related mortality in the COVID-19 peak and non-peak periods.

This study was one of the few studies that assessed the impact of the COVID-19 pandemic on the provision of services to patients admitted to hospitals due to trauma in Iran. The data were extracted from the central and reference hospital in Kerman, a large city in Iran. The findings of the study indicated that the average length of ICU stay decreased from 8 days before the COVID-19 pandemic to 6 days during the COVID-19 pandemic. Besides, the average length of hospital stay decreased from 3 to 2 days. However, it showed no significant difference before and after the COVID-19 pandemic. A national research compared data from the National Trauma Registry before and

after the COVID-19 pandemic [25] and indicated that the length of hospital and ICU stays decreased during the COVID-19 pandemic. Besides, regional studies in Hamadan [26] and Shiraz [27] showed a decrease in the length of hospital stays. A study in California also reported a decrease in the average length of hospital and ICU stays [28]. This finding was predictable because due to the need for hospital beds, especially ICU beds, during the COVID-19 pandemic. Hospitals implemented the policy of immediately discharging patients as soon as their conditions became stable to free up hospital and ICU beds for emergency patients.

The findings of this study also indicated that, despite shorter length of hospital stays during the COVID-19 pandemic, the number of trauma-related deaths was reduced. However, this reduction was not statistically significant. The number and severity of accidents probably decreased due to COVID-19 travel restrictions leading to fewer hospital admissions and deaths. Various studies reported that the number and severity of trauma incidents decreased significantly during the COVID-19 pandemic [29-31]. One of the reasons for the drop in the number of trauma-related mortality was that such deaths occurred before the transfer of patients to the hospital, and these data were not included in the study's data analysis, which could have affected the findings.

The present study also revealed that despite travel bans and restrictions during the COVID-19 pandemic, the number of hospital and ICU admissions due to trauma did not change significantly during the COVID-19 pandemic compared to the pre-COVID-19 era. However, other studies in Iran and other parts of the world found that the number of hospital and ICU admissions decreased due to reducing accidents [25, 28, 32, 33]. This disparity could be attributed to discrepancies across research samples. The data used in this study came from a hospital in Kerman. Although this hospital is a trauma referral hospital, it does not admit all trauma patients from Kerman. Moreover, the duration of the study might influence the results of the studies. Since the COVID-19 outbreak, the conditions in the communities have gradually returned to normal conditions over time, and the differences in hospital admissions between the pre and post-COVID-19 periods reduced. Thus, studies conducted over a longer period showed fewer differences in hospital admissions before and after the COVID-19 pandemic. Although COVID-19 might have reduced the number of accidents, it might have increased some coronavirus-related incidents. Various studies indicated that physical violence and child abuse increased during the COVID-19 outbreak compared to the pre-COVID-19 period [18, 19]. In addition, the difference in the age composition of the population of Kerman could also be one of the factors leading to different findings. Nevertheless, since Kerman Province has a high incidence and death rate due

to accidents [11], further studies are required to examine all the data related to emergency accidents and incidents in Kerman compared to neighboring provinces to obtain more reliable findings about the epidemiology of traffic accidents in Kerman.

This study also found no significant difference in the number of admissions in the ICU, length of stay in the hospital and ICU, and trauma-related mortality during the COVID-19 peak and non-peak times. This finding confirmed that despite a significant increase in medical staff's workload during the COVID-19 pandemic, there was no failure in providing healthcare services to patients in the hospital, especially in the ICUs.

One of the most important limitations of the present study was that the data were collected only from a single hospital, which could affect the study results in several ways. First, since this hospital is a reference trauma reference hospital, patients will be admitted to this hospital more frequently. Second, patients can be hospitalized in other hospitals. Therefore, the study did not include cases whose past admission records were not available in this hospital.

The findings of the present study implied that while the number of COVID-19 patients admitted to the hospitals in Kerman increased significantly during the COVID-19 pandemic and especially during the COVID-19 peak times, leading to substantial workload in the hospitals, medical staff in these hospitals still managed to provide satisfactory emergency services to trauma patients, and the quality of services did not drop significantly.

Declaration

Ethics approval and consent to participate: The proposal of the present study was approved by the ethics committee of Kerman University of Medical Sciences, Kerman, Iran (reference 402000464). The Ethical approval code is IR.KMU.REC.1402.317.

Consent for publication: All authors have read and given their consent for publication of this manuscript.

Conflict of Interest: The authors declare no conflict of interest, real or perceived.

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curation, Resources, Validation, Writing – review & editing. Hossein Mirzaei: Resources, Writing – original draft, Writing – review & editing. Yones Jahani: Conceptualization, Data curation, Formal analysis, Funding acquisition, Investigation, Methodology, Project administration, Resources, Software, Supervision, Validation, Visualization,

Writing – original draft, Writing – review & editing corresponding author

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