ORIGINAL ARTICLE

IMPACT OF COVID-19 PANDEMIC ON ST-SEGMENT-ELEVATION MYOCARDIAL INFARCTION ADMISSIONS AND OUTCOME IN THE NORTH OF IRAN

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Objectives: To determine the incidence of ST-Elevation myocardial infarction (STEMI), patterns of care, and outcomes during the COVID-19 era in a hot-spot region.

Methodology: From February to April 2020, all the STEMI patients were recruited and compared with the STEMI patients in the equivalent period of the previous year. Demographic and clinical information, coronary angiography data, and in-hospital mortality were collected and compared with the non-COVID-19 group. All data analysis was done using IBM SPSS version 20.

Results: There was found a 40% reduction in STEMI admissions during the COVID-19 era compared to the equivalent period in 2019 (55 vs. 92, Rate Ratio (RR):0.60, 95% CI, 0.49-0.70, p<0.001). Compared with the pre-COVID-19 study group, STEMI patients hospitalized during the pandemic were significantly younger (mean age: 56.10 in 2020 vs. 60.83 in 2019 p=0.012). The percentage of primary percutaneous coronary intervention referral was significantly higher than the previous year (47.8% vs. 75.9% p=0.001). In-hospital death occurred in 4 (4.4%) of STEMI patients admitted before the COVID-19 time, while none of the COVID-19 period studied cases died in hospital (p=0.298).

Conclusion: Admissions for STEMI were substantially reduced during the COVID-19 pandemic. No changes in overall in-hospital mortality or quality indicators were detected.

Keywords: myocardial infarction, COVID-19, coronavirus, admission rate, ST-elevation myocardial infarction

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INTRODUCTION

Since December 2019 world has been facing a new critical health challenge known as the COVID-19 pandemic caused by the novel SARS-CoV-2 virus. This pathogen has been responsible for a type of pneumonia that first emerged in Wuhan, China.[1] In addition to China, the U.S., and some European countries, including Italy, Germany and Spain, Iran has been encountering the heaviest burden of the COVID-19 outbreak.[2] The epidemic began in Iran when the first death associated with COVID-19 was detected on February 19, 2020, in Qom, in central Iran. Subsequently, in a short period of time, the infection spread extensively to every other province of the country.[3] The COVID-19 disease has a wide spectrum of clinical signs and symptoms ranging from asymptomatic infection, mild upper respiratory tract disease, severe viral pneumonia, respiratory failure, and even death.[4,5] Cardiovascular complications commonly occur in Covid-19 patients, with challenges in acute management. Furthermore, this infectious disease has a significant implication on patients' cardiovascular care and increases the risk of serious illness and death in patients with underlying cardiovascular diseases (CVD).[5] With the increasing prevalence of infectious outbreaks in the community, the subsequent worries and anxieties have a considerable psychological impact on the general population regarding seeking medical facilities and can affect various parts of the health care system, including the rate and care of emergency admissions as well.[6,7] Of note, some surveys have indicated a substantial decline in the number of patients presenting with acute coronary syndrome as well as the number of emergency coronary interventions in the time of the COVID-19 pandemic.[8,9] Also, the notable influence of this highly contagious coronavirus on the admission incidence of different diseases, particularly acute myocardial infarction, has been indicated in a vast body of literature. This influence in several countries, including the USA and France, has been seen as a decrease in ST-segment elevation myocardial

infarction hospitalizations varying from 18% to 48%, while estimates for certain areas in Spain and Italy reached even to 80%.[7,10-12] These reports contrast the anticipated rise in myocardial infarction rate associated with COVID-19 due to its remarkable impact on the cardiovascular system. For instance, it has been recognized that COVID-19 can aggravate heart damage and lead to a number of cardiovascular complications, including arrhythmia, acute myocardial injury, myocarditis, venous thromboembolism and heart failure. Also the treatment used to manage the disease itself is associated with cardiovascular side effects.[13,14] The possible causes and explanations regarding the drop in myocardial infarction admissions rate during COVID-19 pandemic are not yet fully explained. To the best of our knowledge, limited data about the effects of recent pandemic on the admission rate of patients presenting with acute coronary syndrome, particularly ST elevation myocardial infarction in this region is available. Hence, with respect to the high significance of early diagnosis and treatment of myocardial infarction in improving patients' mortality and morbidity, we aimed to investigate the frequency and outcome of STEMI admissions and related factors in Heshmat cardiovascular diseases center in the north of Iran during the first three months of the pandemic.

METHODOLOGY

This cross-sectional study has aimed to determine the impact of the COVID-19 pandemic on the incidence of STEMI hospitalizations in the north of Iran. From February 20, 2020, to April 20, 2020, all the consecutive patients admitted with the diagnosis of STEMI to Heshmat hospital in Rasht (the only referral center for cardiovascular diseases in Guilan province) were recruited. The same data were collected for the equivalent period of the earlier year as the comparison group (February 20 to April 20, 2019). The study protocol was carried out according to the guidelines of the 2013 version Helsinki Declaration and was approved by the ethics committee of Guilan University of Medical Sciences with the code number: IR.GUMS.REC.1399.246.

In the present study, we focused on STEMI patients since they present with more severe symptoms, so they are more likely to ask for medical care services. At the same time, those with non-ST-elevation myocardial infarction (NSTEMI) may be able to endure less intense symptoms and tend to stay at home rather than reach out to hospitals. Also, STEMI is a simple unequivocal diagnosis that can easily be reached on the field.

Patients admitted to the hospital initially for STEMI who have also been diagnosed with COVID-19 were included. Subjects were excluded if the STEMI diagnosis was disproved in favor of another diagnosis (e.g., myocarditis). The diagnosis of acute STEMI was performed by an experienced interventional cardiologist and was defined as being characterized by ischemic myocardial symptoms and electrocardiographic changes compatible with STEMI (ST segment elevation in at least two anatomically contagious leads; occurrence of pathological Q waves) in addition to dynamic changes of cardiac markers such as troponins or creatine-kinase myocardial band. The number of admitted STEMI cases, patients' baseline demographic data, comorbidities such as diabetes (DM), hypertension (HTN), hyperlipidemia (HLP), smoking status, suspected COVID-19 infection, type of STEMI as well as the type of treatment (use of primary percutaneous coronary intervention (PPCI) or intravenous fibrinolytic), door to balloon and door to needle time, left ventricular ejection fraction (LVEF), data pertaining to coronary artery angiography and intervention (the number of involved arteries, culprit vessel, severity of involvement) and in-hospital mortality rate were collected and compared with the data from the non-COVID-19 group. All the information was gathered from the patients' electronic files by a researcher of the team. After initial examinations and cardiology evaluations by expert cardiologists, patients underwent medical (fibrinolytic) or interventional therapy. Indications for PPCI were based upon the international guidelines.[15,16]

Door to balloon time and door to needle time was defined as the time from arrival to the emergency department to successful wire crossing or the start of intravenous fibrinolytic, respectively.

At the beginning of the epidemic in our country, the RT-PCR technique was not available in this region to confirm the infection by SARS-COV-2. Since the current study was carried out in the same period, the diagnosis of COVID19 was performed based on clinical signs and symptoms according to the WHO guideline, and high resolution computed tomography patterns compatible with the disease.[17]

Continuous variables were presented as mean and standard deviation (SD) and were compared using Independent Sample T-test, while categorical variables compared using Chi-square test. P values less than 0.05 were considered significant. All data analysis was done using IBM SPSS version 20.

RESULTS

Detailed information about patients' characteristics is shown in Table1. A total of 55 STEMI cases were admitted during February and April 2020, with a 40% reduction (Rate Ratio (RR): 0.60, 95% CI, 0.49-0.70) compared to the equivalent period in 2019 when 92 patients were registered for the same diagnosis (p<0.001). Out of 55 STEMI cases admitted to the hospital in 2020, 17 patients were diagnosed with concurrent COVID-19 infection.

Table 1. Demographic and clinical characteristics of patients with STEMI during and before COVID-19 pandemic

Characteristics	Before COVID-19	During COVID-19	P-value
Total (N)	92	55	
Age (year)	60.83 ± 12.27	56.10 ± 8.16	0.012
Gender			
Male	72(78.3)	47(85.5)	0.282
Female	20(21.7)	8(14.5)	
Risk factors			
Diabetes	25(27.2)	6(10.9)	0.019
Hypertension	39(42.4)	25(45.5)	0.717
Dyslipidemia	25(27.2)	10(18.2)	0.215
Family history of myocardial infarction	20(21.7)	7(12.7)	0.172
Smoking	37(40.2)	25(45.5)	0.534
Treatment*			
PPCI	43(47.8)	41(75.9)	0.001
Thrombolytic	47(52.8)	13(24.1)	
Angiography			
Single vessel disease	20(25.6)	15(27.8)	0.753
Two vessel disease	31(39.7)	18(33.3)	
three vessel diseases	27(34.6)	21(38.9)	
Outcome			
Dead	4(4.4)	0(0)	0.298
Alive	88(95.6)	55(100)	

P-value <0.05

** Data on treatment was missing in two patients in the before COVID-19 group and one in the COVID-19 group.*

Compared with the pre-COVID-19 study group, STEMI patients hospitalized during the pandemic period were significantly younger (mean age: 56.10 in 2020 vs. 60.83 in 2019 p=0.012). The reduction of admission for females (RR: 0.4, 95% CI, 0.22-0.71) was higher than males (RR: 0.65, 95% CI, 0.54-0.77), but the result was not statistically significant (p=0.28). There was a 76% decrease in hospitalization of diabetic patients with the diagnosis of STEMI in 2020 compared to the equivalent period in 2019 (RR: 0.24 95% CI, 0.11-0.50, p=0.019). Moreover, there was no interaction of reduction of hospital admissions with history of HTN (36% decrease in patients with HTN [from 39 to 25 RR: 0.64, 95% CI, 0.49-0.82] vs. 44% reduction in patients with no history of HTN [from 53 to 30 RR: 0.56, 95% CI, 0.43-0.71]), HLP (60% decrease in patients with HLP [from 25 to 10, RR: 0.40, 95% CI, 0.23-0.68] compared to 33% decrease in patients without HLP [RR: 0.67, 95% CI, 0.56-0.80]) and smoking status (33% reduction in smokers [from 37 to 25, RR: 0.67, 0.52-0.85] vs. 46% decrease in non-smokers [RR: 0.54,0.41-0.69]) between the two periods. The result of RR related to admission reduction is set out in Figure 1.

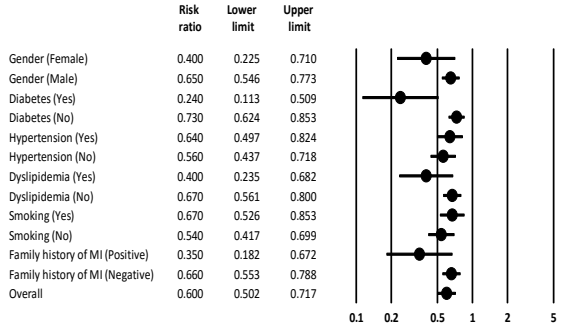

Figure 1: Rate ratios related to admission reduction in different groups

The present study regarding the types of treatments performed on patients demonstrated that in COVID-19 time, the percentage of PPCI referral was significantly higher than the previous year (47.8 % vs. 75.9 % p=0.001).

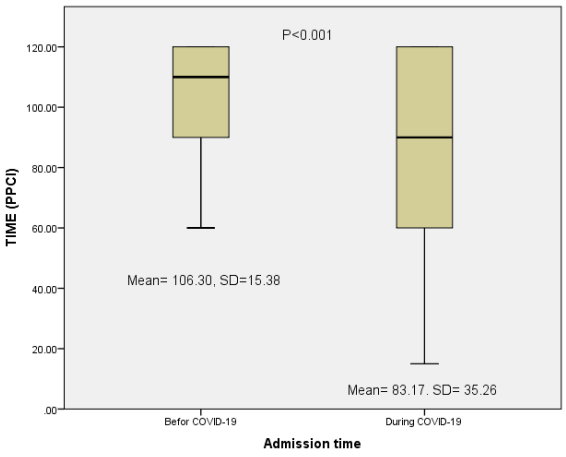

Figure 2: The mean of time to PPCI before and during COVID-19 era

Also, the mean of the door to balloon time during the COVID-19 era was significantly less than the pre-COVID-19 time (83.17 [SD= 35.26] vs. 106.30 [SD= 15.38], p<0.001) (Figure 2). No significant differences were found between the mean of EF of the patients in the COVID-19 era compared to the non-COVID studied population (mean of EF: 39.45% vs. 36.67%,

respectively, p=0.067) (Figure 3). Finally, in-hospital death occurred in 4 (4.4%) of STEMI patients admitted before the COVID-19 time, while none of the COVID-19 periods studied cases died in hospital (p=0.298).

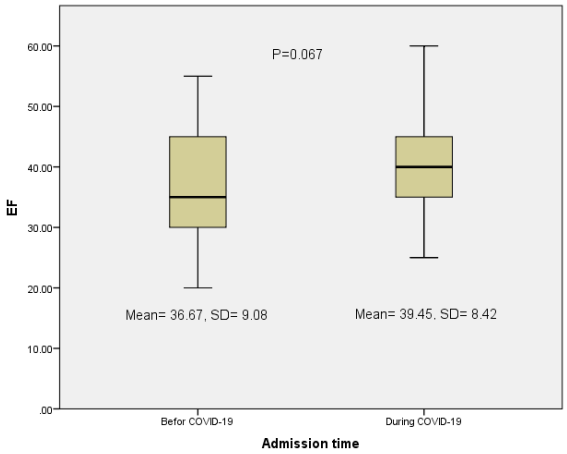

Figure 3: The mean of ejection fraction before and during COVID-19 era

DISCUSSION

This study found a dramatic decline in STEMI admissions during the COVID19 pandemic compared to the previous year's equivalent period in the north of Iran, which reflects those observed in earlier studies.[7,10,18-21] A registry study in France noted a 24% decline in hospital admissions for STEMI between the periods directly before and after the lockdown, and according to the US and Spain cardiac catheterizations laboratories, 38% and 40% reduction in STEMI activation were reported, respectively.[7,21] Recent data from northern California and a multicenter Italian registry indicated a striking decrease in acute MI hospitalizations during the COVID-19 era compared to the same period last year.[9,19] Wilson SJ et al.[22], evaluating the COVID-19 pandemic impact on STEMI presentations and outcome in the UK, reported a fall of about 50% in admissions. The reasons for the reduction in the STEMI admission rate are presumably multifactorial. The possible explanation might be the reluctance of patients to attend hospitals due to the great fear of exposure to SARS-COV-2 infection, particularly in those with atypical or less severe acute coronary diseases symptoms. As it is known, fear is a famous determinant of medical care-seeking avoidance and is strongly associated with epidemics.[10,19-21] Additionally, this concern could have been intensified by the public health messages regarding encouraging people to stay at home. Another probable explanation may be the misinterpretation of MI symptoms (e.g., chest discomfort and dyspnea) as COVID-19 presentation, which also avoids asking for medical help in favor of self-quarantine. Moreover, lockdown and intense social isolation have resulted in decreased physical activity and work-related stress, which are considered as potential triggers of MI in high-risk patients. It is worth mentioning that improved hand hygiene and preventive protocols (e.g., masks and social distances) might also have contributed to a considerable reduction in the prevalence of other respiratory viral infections such as influenza, which has been previously reported as a strong trigger of MI in at-risk individuals.[7,9,19-21] In a meta-analysis by Sofi F et al., it was revealed that contrary to what may have been expected, epidemiological measures and social policy parameters (e.g., lockdown measures) related to COVID-19 were not associated with the different incidence of STEMI hospitalization across countries. In contrast, the different organizations of emergency medicine programs and/or hospital operations during the pandemic may have played a role.[23]

In our study, STEMI patients admitted to the hospital during the COVID-19 era were significantly younger than the previous year. In line with our study, according to the France registry, the decrease of MI admissions was greater in old patients (80 years and over).[7] However, in some other inquiries, patients who were hospitalized in the COVID-19 era with MI diagnosis were reported to be older than the pre-COVID-19 reference group.[13,19] Furthermore, we found a major decline in the admission of STEMI patients with a history of diabetes, hypertension, and hyperlipidemia compared to the non-COVID-19 period; nevertheless, except for diabetic patients, the differences were not statistically significant. These findings can be interpreted as a greater fear of being infected and having a worse clinical situation in older patients and those with comorbidities. It has been proposed that the COVID-19 pandemic leads to a high mortality rate among patients with comorbidities such as diabetes, hypertension, cardiovascular diseases, and chronic respiratory diseases.[4,24,25] Albeit, in some previous studies, the admission rate reduction was of a similar magnitude across all subgroups in terms of the presence of comorbidities such as diabetes and hypertension.[7,9]

In the current survey, medical delays (explained as the door to balloon time) were significantly shorter during the pandemic, and rates of PPCI performed on STEMI patients in the COVID-19 era were higher than the same period last year, which indicate that the efficacy of the care pathways and hospital strategies for STEMI patients have not been affected by the outbreak.

Collectively, no differences were observed in the number of STEMI in-hospital deaths during the pandemic compared to the reference period. Likewise, Mafham M et al. study demonstrated that no overall increase in in-hospital mortality had been observed among patients admitted with the acute coronary syndrome in the UK during the pandemic; however, it should be noted that our study focused on STEMI patients admitted in the COVID-19 era compared to the equivalent time in the previous year. In contrast, a number of previous studies reported a substantial increase in STEMI patients' mortality rate in the COVID-19 period.[19,22] This rather contradictory result may be due to the differences in study periods, population, or designs, and the fact that countries have been through various stages of the outbreak and have experienced different burdens of the pandemic at the time of their study.

The results of our study provide further support for the hypothesis that in the epidemic situation, acute MI patients may evade attending hospital emergencies or defer going, which can result in several detrimental consequences, including out-of-hospital deaths. MI patients seeking hospitals with delay or not reaching out for medical help could experience longer infarct, severe heart failure, and malignant arrhythmias. Accordingly, irrespective of the reasons, the reduced rate of acute MI admissions is worrisome and can rise to considerable cardiac complications.[7,20,21]

Our study should be considered in the context of the following limitations. It was a single-center study investigating STEMI patients' admissions rate in two months in the context of the general lockdown. At the beginning of the epidemic in our country, the RT-PCR technique was not available to confirm the infection by SARS-COV-2. Regarding the interaction of MI admission with risk factors, it should be noted that in different years among people with the same risk factor, the prevalence of STEMI is comparable, which is likely but actually unknown. Moreover, as known from the literature, the lockdown carried potentially confounding factors (e.g., lower pollution, less physical activity), reducing the overall STEMI prevalence. Lastly, our sample size is relatively small but represents the data from the only referral cardiovascular diseases medical center of the Guilan province in the north of Iran.

CONCLUSION

In conclusion, this single-center observational study demonstrated a substantial decline in STEMI hospitalizations during the COVID-19 pandemic. No changes in overall in-hospital mortality or quality indicators were detected.

AUTHORS' CONTRIBUTION:

SN: Concept and design, data acquisition, interpretation, drafting, final approval, and agree to be accountable for all aspects of the work. AS, FM, AV, SH, ER, RA, AFM, JK: Data acquisition, interpretation, drafting, final approval and agree to be accountable for all aspects of the work.

Conflict of interest: Authors declared no conflict of interest.

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